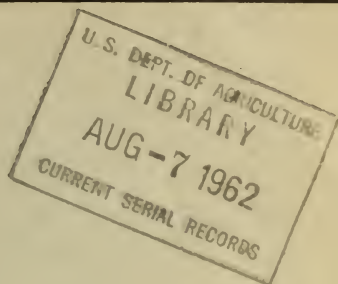


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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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If there is any introductory or explanatory information, it should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Text for illustrations should be typed on strip of paper and attached to illustrations. All diagrams should be drawn with the type page proportions in mind, and lettered so as to reduce well. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

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FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Because of unforeseen circumstances volume 2, 1938, consisted of but one issue. Yearly subscribers will, however, receive four complete copies of the publication.

RECENT DEVELOPMENTS IN LOOKOUT TOWERS

H. R. JONES

*Assistant Chief Engineer, Division of Engineering, U. S. Forest Service,
Washington, D. C.*

The issue between steel and timber lookout towers has been the subject of vast amounts of correspondence, charges, counter charges, and high emotions. The author, however, presents here a dispassionate factual statement on the present status of tower purchases and designs.

Previous to 1933 lookout towers purchased on the basis of plans and specifications were of structural steel.

About that time there were coming into use in this country, timber connectors which, in comparison with ordinary bolted or spiked joints, greatly facilitated the transmission of stress through joints in timber structures. The connectors as used in Forest Service lookout-tower construction consist of metal rings which are placed between two timbers, the connecting bolt passing through the center of the ring. The ring, with half its width projecting into the contacting face of each timber, transmits the stress from one timber to the other. These connectors are commonly used in CCC portable camp buildings.

The development of the timber connectors and resultant increased possibilities for economical use of timber led to its consideration for lookout towers, a matter in which the lumber industry and the Forest Service were much interested. An attempt to purchase towers showed that the industry was not prepared to produce prefabricated timber in competition with the steel industry, where prefabrication was a long established practice. However, in view of the Forest Service's interest in developing the economical utilization of woods, eight towers were purchased on a specification restricted to timber, as an experimental project. Reports of this project indicated that fabrication was decidedly defective, causing long delays during erection. As a result, tower bids were again limited to steel.

Pressure on the Forest Service to consider timber gradually increased as the timber industry improved its methods of prefabrication and the large purchases of towers in connection with the CCC program so stimulated this pressure that the subject was reopened.

In the meantime, some timber designs had been worked up in the regions. Region 6, which had been the most active in this connection, was asked in August 1936 to review the entire tower problem, considering comments and plans from all Forest Service regions. The study consumed 5 months. The report indicated conclusively that prefabricated timber structures could compete with steel, at least on the Pacific coast, and since plans for some timber towers were practically completed, a purchase then about to be made was handled on bids providing alternate offers on timber and steel. On that and subsequent proposals there have been purchased 135 timber towers.

Region 6 timber designs and Region 7 steel designs were selected as standard to be used for all purchases of towers within the range of sizes and heights they included.

In order to provide steel and timber plans for towers of practically equal heights—a necessary condition for competitive bids—consider-

able revision of existing steel plans and new steel designs was made in Region 7. Designs have now been completed for the following towers:

Towers for 14- by 14-foot lookout houses: Steel—30 feet, 41 feet 3 inches, 54 feet, 67 feet, 83 feet 1½ inches, 100 feet 4½ inches, 120 feet. Timber—30, 41, 54, 65, 83, 100, and 117 feet.

Towers for 7- by 7-foot cabs: Steel—30 feet, 41 feet 3 inches, 54 feet, 67 feet 6 inches, 82 feet 6 inches, 99 feet 9 inches, 120 feet. Timber—30, 40, 52, 66, 82, 99, and 119 feet.

Height is measured from top of footing to approximately the cab floor level.

The Washington Office usually purchases timber or steel towers for 7- by 7-foot cabs complete with timber or steel cabs. Towers for the 14- by 14-foot house are purchased usually without the house which is made of lumber for both timber and steel towers. Purchase and erection of the house are handled by the office ordering the tower. A recent purchase was made of steel towers complete with prefabricated lumber houses, and it is hoped that this will prove feasible.

The specifications recently used for competitive bidding between steel and timber do not take into account any differences, advantages, or disadvantages of the two materials, except that freight charges are considered and purchases are on the usual basis of lowest cost at rail point to which shipment is made. The specifications, therefore, may not actually provide for competition on a truly equal basis. The problem of arriving at equality in this respect is complicated by the fact that a few of the differences are considered to be debatable, and others vary with locality. To illustrate:

(a) Fire hazard is considered to be a disadvantage of timber. Treatment with fire resistant material is a possible development.

(b) Depreciation or life term is considered equal. No records are available which would substantiate a difference here, assuming that the time consideration is held within a period usually applied for accounting purposes.

(c) Maintenance costs are unknown, but records are being obtained. A period of several years will elapse before conclusive figures are available.

(d) In the eastern part of the country inspection costs have been greater for timber than for steel. Because of inadequate inspection some poor material has been received recently, necessitating reinspection of towers at several places. Accurate fabrication is a prerequisite for economical erection, and it is reasonable to expect that some day prefabricated timber of standardized quality of material and workmanship on a par with the product of steel fabricating shops will be available.

(e) Records have been kept of the erection costs of timber towers, and erection costs will be kept on the steel designs which will provide accurate comparative information.

(f) The cost of lightning protection is greater for the timber tower.

(g) Transportation from railroad to tower site is more costly for the timber tower because of its greater weight, particularly where pack horse transportation is necessary. Comparative weights taken from the Region 6 report will illustrate this point:

Shipping weights of 100-foot tower and 7- by 7-foot cab

	Pounds
Steel.....	18, 200
Timber, Douglas fir.....	27, 000
Timber, southern pine.....	31, 000

These weights do not include cement, sand, gravel, or water for the concrete footings. Total hauling costs will be influenced by the local conditions controlling the availability of these materials.

If hauling cost per ton-mile from rail point to tower site were definitely determined, it would be a simple matter to consider this cost difference in making award. Similarly, the other differences, insofar as they can be definitely determined, could be evaluated.



Byrne Memorial Tower.

The lookout tower is not ordinarily considered for structures of monumental character. The accompanying photograph of the Byrne Memorial Tower, designed and constructed by Region 8, in memory of John B. Byrne, a former supervisor of the Nantahala National Forest, indicates the possibilities of lookout towers for the purpose. What could be more appropriate?

DETERMINATION OF THE RATE OF SPREAD OF FIRE IN THE SOUTHERN APPALACHIANS

GEORGE M. JEMISON

*Associate Forester, Appalachian Forest Experiment Station,
U. S. Forest Service*

Rates of spread vary in a bewildering way. It would be easy to yield to the temptation to throw up our hands and say that it is useless to try for anything but good guesses at the rate a given fire will spread under given conditions of fuel, weather, and topography. The saner attitude is to keep digging away at the effect of this or that factor on rate of spread in the belief that in time the intricate puzzle will be solved by the creation of something that can rightfully be called the science of rate of spread. The author is doing just this for the specific combinations of conditions involved in the southern Appalachians.

Rate of spread of fire in specific fuel types under given conditions influences all major phases of forest-fire control, but accurate data on this subject are difficult to obtain. Estimates only are often used as a basis for planning fire-control needs.

Concepts of fuel type and fire-danger rating are new, especially in the East, and the probable rates of spread associated with different combinations of fuel type and fire danger are difficult to estimate. Actual measurements of fire behavior are desirable for even preliminary presuppression and suppression plans.

Three possible ways of obtaining rate of spread data for different fuel types and fire-danger classes are: (1) Analysis of fire reports accumulated in past years; (2) observation of actual forest fires; and (3) study and measurement of experimental fires ignited in specific fuel types and burning under measured conditions.

Because most fire reports contain no data from which fire-danger class and fuel type can be obtained without intimate knowledge of the fires in question, the first method usually yields a limited amount of fire-behavior information. This method has an additional disadvantage because rate of spread in chains of perimeter per hour must be derived from estimates of perimeter on arrival and hours since origin or discovery. The figure obtained on rate of spread is likely to be biased because of the tendency to overestimate perimeter in rough country under the pressure that usually accompanies arrival at a fire. Since time of origin is seldom known accurately and some spread usually precedes time of discovery, the use of either of these as a basis for computing elapsed time results in some degree of error. Finally, few fire-danger rating schemes permit determination of danger class from fire reports, because fuel-moisture content at the time of a fire is seldom known.

The second method requires a large, well-trained, and widely distributed group of observers if the study of actual fires is to be profitable. It is probably more adaptable to eastern fires, where the

initial attack usually is made by crews, than it would be in the West, where smoke chasers are used.

The use of experimental fires, a very desirable method, requires expensive preparations and is all but impossible in mountainous regions where fire behavior is complicated by topography, a variable difficult to control. Also, the hazard in setting fires on days of high danger in fast rate-of-spread fuel types prevents study of fires under extreme conditions. This is especially significant in most forest regions, because major losses in acreage and greatest suppression costs result from a few bad fires. On the Pisgah National Forest in North Carolina, for example, during the past 6 years, only 3 percent of the 466 fires accounted for 56 percent of the burned acreage. All of these fires occurred on days when the fire danger was class 4 or 5, the two highest ratings on the Appalachian fire-danger meter. Similarly, 40 percent of the total suppression costs were required by only 12 percent of the total number of fires, eight out of ten of which burned on class 4 or 5 days.

The Appalachian Forest Experiment Station, cooperating with Forest Service Regions 7 and 8, has combined methods 1 and 2. The approaches used may be of interest to others.

Rather than attempt to rate fuel types in the conventional terms of low, medium, high, and extreme rate of spread and resistance to control, 14 modified timber types were defined with special reference to the factors thought to contribute most to spread and resistance. The initial procedure of classifying fuel types in the Appalachians, which differed somewhat from the methods used elsewhere, was started by the Region 7 office of fire control in cooperation with the experiment station. It is believed that much more uniform recognition of these basic types by field men is made possible by this method. Of course, the 14 types can be reclassified into low, medium, high, and extreme groups as soon as rate of spread and resistance to control becomes definitely established for each type.

The first approximations of rate of spread and resistance to control were made in September 1937, by C. A. Abell, then of this station, who used data from reports of 1,560 fires on which fuel type had been identified by Region 7 rangers. The descriptive classification of the 14 types enabled these men to code the fire reports for the past 7 years and show the fuel type in which each fire burned. Although no attempt was made to correlate rate of spread and fire-danger class by fuel type in this preliminary study, the data were arbitrarily divided into groups to represent ordinary, moderate, severe, and extreme burning conditions.

The first determinations of fire occurrence and behavior in relation to fire danger were made from analysis of Pisgah National Forest fire records for 1932 to 1937. Such an analysis of reports for previous years could be made because the present form of the Appalachian fire-danger meter permits the rating of danger from the records obtained at any first order weather station. The analysis,¹ in part, produced the results shown in table 1. These data must be considered as preliminary because they are averages for two major fuel types, and danger classes were determined from only one station. However, the trends are very definite and the relation between danger classes is well shown.

¹ For a complete report of this analysis see Technical Note No. 27, February 1, 1938, Appalachian Forest Experiment Station, Asheville, N. C.

TABLE 1.—*Relation between class of fire danger and occurrence, rate of spread, and area of fires*¹

Class of fire danger	Occurrence probability		Percent of class days on which fires occur	Rate of spread, perimeter per hour (origin to arrival)		Average perimeter increase per hour during corral	Average final area per fire
	Fires of all causes	Exclusive of debris burner and incendiary fires		All fires	Fires attacked within 12 hours		
1	1.0	1.0	2.5	<i>Chains</i> 1.3	<i>Chains</i> 4.6	<i>Chains</i> 3.2	<i>Acres</i> 3.9
2	1.8	1.4	5.5	3.2	7.1	6.0	4.2
3	8.0	4.0	18.0	8.2	10.6	8.0	7.4
4	22.8	9.5	39.0	12.8	17.1	9.1	25.0
5	56.2	28.6	59.5	16.2	20.0	9.9	45.8

¹ Based on 440 to 467 fires on the Pisgah National Forest, 1932-37, inclusive. Class of fire danger from Asheville, N. C., weather records, using Appalachian fire-danger meter.

The preliminary rate-of-spread data for the various fuel types and danger classes are being systematically checked on the southern Appalachian Mountain forests by a corps of 125 trained CCC fire observers. This work was carried through the 1937 fall and 1938 spring fire seasons, and some features of it have produced worthwhile results. These fire observers, who are carefully selected and trained by the station, accompany suppression crews to fires and have no duties other than measuring and recording certain data on fire behavior.

When an observer reaches a fire, his first job is to mark its perimeter by blazing a line around it as quickly as possible. If fires are in very rough country or are so large that to encircle them would require more than 20 minutes, the fire boss supplies an estimate of perimeter, as in the past. When the blazing method is used, the observer, with an assistant, carefully chains the marked perimeter after the fire has cooled down sufficiently for him to locate the blazed line. In many cases this method supplies a more accurate rate of spread figure than would otherwise be obtained.

Rangers or their assistants are responsible for identifying the fuel type at the spot of the fire as one of the 14 standard classes. Observers were initially trained to describe character, volume, and arrangement of dead fuel on the ground, but because of the varying conditions on actual fires and the resulting confusion this phase of the work was soon dropped.

Fire observers are equipped with four 16-ounce tin sampling cans in which they collect surface litter. These samples are mailed to the station, where the fuel-moisture content is determined. This procedure furnishes more accurate fuel-moisture data for danger rating than does measurement at an established fire-danger station some distance from the fire.

Other factors necessary for rating fire danger are obtained at the nearest danger station while the fire is burning, a procedure probably satisfactory for rainfall and humidity. Wind velocity varies greatly with locality, however, and measurements at the nearest station may not truly indicate winds at the fire. An attempt was made to train fire observers to estimate wind velocity, but this was discontinued when it became apparent that the results were grossly in

error. Unfortunately, the use of wind instruments is too expensive.

The essential features of the method of rate-of-spread determination used by the Appalachian station in cooperation with Forest Service Regions 7 and 8 are:

1. Classification of fuel types strictly on the basis of stand characteristics with special reference to dead fuels. Although requiring a more detailed initial classification this procedure is more accurate than some of the others because it eliminates chances for personal errors.

2. Analysis of fire reports to obtain preliminary rate-of-spread data for each fuel type. This method of fuel-type classification facilitates accurate identification of fuel type for each fire report.

3. Preliminary determination from fire reports of fire behavior associated with each class of fire danger. Definite trends of differences in rate of spread under different conditions can be established by this method.

4. A detailed check of preliminary rate-of-spread determinations by means of observations on going fires. Experience has shown that CCC observers can obtain better measurements of perimeter on arrival than have been obtained in the past. Collection of fuel samples at fires for later moisture determination is well worth while, but in the Appalachian region estimation of wind velocity and detailed description of character, volume, and arrangement of fuel has not proved satisfactory.

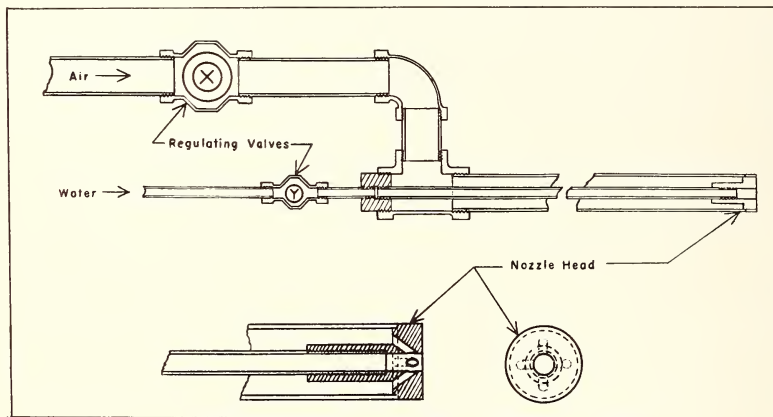
TESTS ON THE USE OF COMPRESSED AIR IN FIRE SUPPRESSION

C. LORENZEN, JR.

Formerly junior engineer with the California Forest and Range Experiment Station, U. S. Forest Service

Everyone knows that the efficiency of 10 gallons of water in fire suppression depends on the way it is used. Testing the relative efficiency of chemicals and water doesn't mean much unless the water is used in the most efficient way. What is the most efficient way of using water? In a solid stream? In the form of spray? Under high pressure? Or low pressure? Mixed with air under pressure? If mixed with air, how much air, how much water, and under what pressures? The author records one attempt to find more efficient ways of using water.

The use of compressed air in fire suppression has been suggested to control backfire, to remove litter in fire-line construction, and to increase the efficiency of water. At the Spokane fire-equipment



Air-water nozzle.

conference (1936) this subject was assigned to the California Region for investigation.

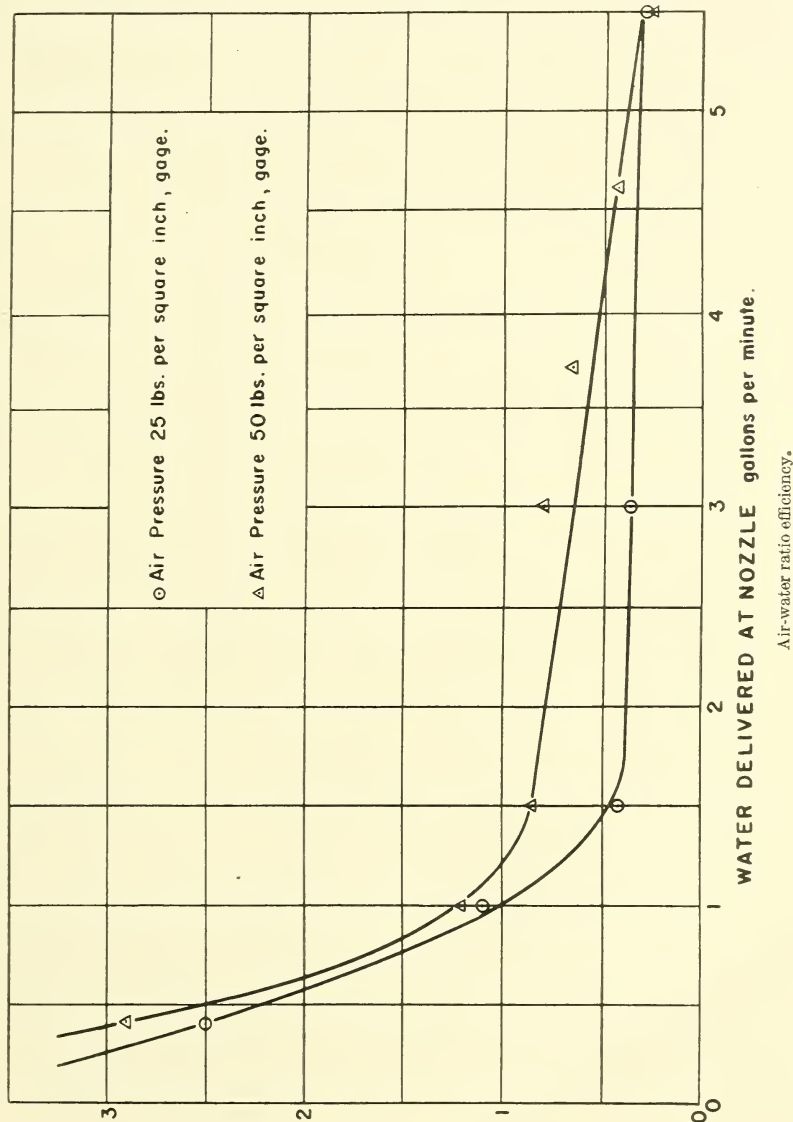
A few preliminary tests served to demonstrate the impracticability of using compressed air for the rapid removal of forest litter in fire-line construction. The remaining tests were concerned with the use of air-water nozzles for fire suppression.

After some experimenting a nozzle embodying a mixing chamber was developed by F. C. Lindsay, formerly on the Plumas National Forest, for obtaining different air-water ratios. Water pressure was kept constant at 30-40 pounds. The water-flow rate was varied by adjustment of a regulating valve in the line.

To test the efficiency of the nozzle at various air-water ratios, 17 small fires, averaging from 10 to 15 feet in diameter, were burned in fairly clear plots of ponderosa pine litter. The fires were set under conditions of little or no wind and were allowed to spread to

a predetermined size. The rate of suppression with the nozzle was then measured, the time to knock down the flame and to completely mop up the smouldering litter being recorded. Water for the tests was supplied from a 450-gallon tank truck, and air was obtained

TIME IN MINUTES TO SUPPRESS 100 SQ. FEET.



from a portable compressor. Water pressure of 30-40 pounds per square inch gage was held constant throughout this series of tests, and water-flow rates over the calibrated range were used at air pressures of 25 and 50 pounds per square inch.

The data obtained in these tests (see chart) show that there exists a very definite optimum value of water rate for a given air pressure. For higher air-water ratios (above this region) the effectiveness of the nozzle drops rapidly, while for lower ratios there is a rapidly increasing waste of water. The curves show the optimum occurring at a water rate of about $1\frac{1}{4}$ gallons per minute for an air pressure of 25 pounds per square inch. The curves for air pressures of 50 and 100 pounds per square inch were of similar shape. For these rates the data indicate that any air pressure above 50 pounds per square inch is undesirable.

Comparison of the action of the air-water nozzle with that of the conventional water-spray nozzle was obtained on six additional ponderosa pine test fires. In each test a plot was measured, divided into two equal areas, and burned off. The different methods were then applied to the two areas and the total mop-up times recorded. The water rates for both methods were equal in each case, giving a direct indication of the effect of the addition of air to the water. The time difference in each test was too small, compared to the total suppression time, to indicate any superiority for the air-water nozzle. Similar suppression time tests on 6-foot sections of burning logs showed no appreciable time difference between the use of water-spray and air-water nozzles.

Although the tests showed that the air-water nozzle was not superior to the water-spray nozzle for fire suppression, two valuable suggestions were obtained. First, the optimum air-water ratios found suggest that optimum flow rates and nozzle types for given water pressures could be determined by similar experiments for water-spray nozzles. Second, while the additional oxygen supplied the fire by compressed air is a disadvantage, the force added increases the penetrating power of the stream without increased water consumption. It would, therefore, appear desirable to test the use of CO_2 gas under pressure in lieu of compressed air.

FOREST FIRE-FIGHTING PUMPS

Forestry Branch, Department of Lands and Forests, Ontario, Canada

Fire Control Notes hopes to serve fire-control men in Canada as well as in the United States. This contribution on fire pumps is, therefore, particularly welcome. Moreover, a discussion on portable pumps is very much in point on the southern side of the international boundary at this time. A special effort is being made by the Forest Service of the U. S. Department of Agriculture to raise specifications—and get manufacturers to follow. This organization, like the Ontario Forestry Branch, leans toward lighter weight for portable pumps. The present specification prescribes not to exceed 75 pounds for one-piece units and not to exceed 100 pounds for two-piece units. In the two-piece units the heavier of the two pieces may not exceed 60 pounds.

During the last 25 years or more manufacturers have been designing and building different types and sizes of gasoline-driven, portable, fire-fighting pumps for use in forest-fire protection, with the idea of finding one unit which would be satisfactory to all forest-protection organizations. Such a unit seems to be but another dream; certainly it has not yet materialized. Possibly the protection organizations are expecting too much, but some are still striving to obtain units suitable to their own particular set of conditions, one organization leaning more toward a heavier unit, another toward a lighter unit. Ontario falls in the latter class.

The general specifications of a fire-fighting unit most suitable to meet conditions in the Province of Ontario call for one which would be:

1. As light as good construction and simple reliable operation will permit, weight in any case to be less than 100 pounds.
2. Compact and of a form suitable for back packing and aircraft shipment; the unit to have a low center of gravity and wide base, in proportion to size, for ease in set-up; delicate or easily damaged parts to be protected, as far as possible, by the design of the unit.
3. Capable of pressures up to 200 pounds (higher pressures are not desired in view of the danger of hose damage); volume capacity to be as uniform throughout the unit's working range as practicable; unit to deliver at least 20 gallons per minute at 150 pounds pressure.
4. Capable of operation against any variation of load on the hose line, so that the entire flow may be cut off or the unit operated against no load without damage to the unit or interruption in water supply.
5. As economical of fuel and oil as is consistent with the required pressure and volume capacity.
6. Easy and economical to repair and service.

In attempting to construct a unit suitable to conditions in Ontario and with these rather severe limitations, it was necessary to investigate the capabilities of a great number of possible combinations of motors and pumps, since no existing unit fulfilled the requirements. The unit which has finally been assembled has characteristics which can be conveniently listed against the stated requirements as follows:

1. Weight approximately 80 pounds.
2. Dimensions of base $23\frac{1}{2}$ by $11\frac{1}{2}$ inches, height 12 inches. Spark plugs, carburetor, and fly-wheel adequately protected. Base flanged for back packing and fitted for pack straps; lifting band provided at the point of balance.

3. The unit will deliver 28-30 Imperial gallons per minute at 200 pounds pressure, 35 gallons per minute at 150 pounds pressure, and 40 gallons per minute at zero pressure.

4. The unit is self priming; can be run with delivery cut off or with open discharge. This is accomplished by the use of a special relief valve which opens as the motor loses speed. A part of the valve mechanism is linked to the throttle, thus providing a control when running against light loads. The throttle may also be operated manually. The unit has no running gas tank; fuel is supplied by an automotive type fuel pump. A small gravity tank, for starting, is included in the fuel system. The unit has no grease cups; the motor is self oiling from the fuel supply. The pump shafts are mounted on ball bearings which require lubrication once a year. These bearings are protected from water and grit.

5. The power head of the unit is made up of a light, two-cycle, water-cooled gasoline motor with a normal operating speed of 4,000 r. p. m. Average loads will allow a speed of approximately 3,500 r. p. m. The motor's horsepower rating at this speed is approximately 7.5. The fuel consumption, following an 85-hour test run at full throttle, averaged slightly less than 1 gallon per hour. Oil is mixed with the gasoline at the rate of $\frac{3}{4}$ pint to 1 gallon of gasoline.

6. Repairs to major working motors part should not be required under 500 hours running time. Replacement of main running parts when required will aggregate approximately \$35. The pumping surfaces are completely replaceable for less than \$15. Because of the design of the pump, pumping surfaces do not touch, so that wear is almost entirely dependent upon the sand content of the water. All pumping surfaces are of rust-resistant material.

Once properly set up and started, the unit should require no attention other than the replenishing of the fuel supply.

SYSTEMATIC GUARD TRAINING BY TELEPHONE

R. F. COOKE

District Ranger, Mount Baker National Forest, U. S. Forest Service

We all know that fire-guard inspection on the ground can be supplemented effectively by use of the telephone. But knowing the large potential value of the telephone for inspection, supervision, and maintenance of zest is one thing, while making actual use of it for those purposes is quite something else. Here is one busy forest executive who has an interesting accomplishment to report.

The telephone has been used incidentally in training guards on the Mount Baker National Forest for several years, and the last 2 years its use has been on a planned basis. The results are gratifying. It is our observation that although telephone training does not replace personal contact training and inspection, it reduces considerably the amount of time needed for field contacts.

Under a planned system of telephone training, a fake fire report is required from each lookout once a week. The location of the supposed fire is platted by the protective assistant, and any items in the report that do not check with the platting are called to the lookout's attention. Usually he is told only that he has made a mistake and asked to find and correct it. If he finds the mistake himself, he is more likely to remember and not make it again. The report is next platted on the lookout panoramic photograph, and the protective assistant calls the lookout's attention to any additional local landmarks that show up in the picture (a strong reading glass is useful in studying the picture and picking out landmarks).

In using CCC enrollees as emergency lookouts, it is often necessary to detail a man who has had some training but is unfamiliar with the country. These men can be given a good working knowledge of the area they observe by platting the location of streams, lakes, ridges, etc., on the panoramic photographs and giving them the names, azimuths, and vertical angles over the telephone. They can then shoot the points with the fire finder and spot them on the map. Personal inspection has shown that this system enables the men to acquire a good working knowledge of their territory.

Every 2 weeks the protective assistant makes up a list of 20 to 25 questions, using the guard handbook and lookout manual as references, and telephones them to all the fire guards. These questions are worded for a "yes" or "no" answer as much as possible. Starting about 2 days later the protective assistant calls each guard separately and takes his answers to the questions. They should all be correct as the men have their handbooks and manuals for reference. In this way the ranger can be sure that the handbooks and manuals are read and correctly interpreted. Following are a few sample questions:

1. Would a dirty sack on the wet bulb of the psychrometer cause an erroneous humidity reading?
2. What is the correction factor used when orienting one fire finder with another?
3. What would be the correction by the above factor if the lookouts were 20 miles apart true north and south of each other?
4. Is it permissible to use equipment from your fire-chaser outfit around your lookout station?
5. Is section 36 in the northeast corner of a township?

A fourth step in this telephone training: Once a month each guard is asked to make up a list of 10 or more questions on any points of his job on which he desires more information. These questions are telephoned to the protective assistant in a session with all guards on the line, and as each question is read by the man giving it, the protective assistant asks another guard to answer it. If no other guard can answer the question, the protective assistant answers it or refers it to the district ranger. I consider this one of the most important steps, as it clears up many things for the guards. It also trains the protective assistant, and often the district ranger, because frequently points are brought up that he never thought of in making presuppression plans.

In addition to the schedule as outlined, individual problems are given the guards at odd times for them to work out: To recreation or administrative guards, hypothetical problems of law enforcement or public contacts or whatever their line of work may be; for firemen, problems in chasing, what route they would take to reach a fire in a given location, what they would do under certain given conditions on a small fire; for lookouts, calculation of fire size from fire-finder readings, routing of men to a fire in a given location; for the more experienced guards, problems in dispatching, calculation of man power needed for a given size fire in a given location under certain conditions, and action in unusual circumstances. Following are some problems that have been used:

1. A small party of visitors stops at your station and asks you the route to Mount Shuksan. They say they have never climbed a mountain before and their clothes and equipment look unsuited for mountain climbing. State what action, if any, you would take in these circumstances.

2. The rate of travel on this district is 25 miles per hour on roads, 2 miles per hour on trails, and 1 mile per hour across country. A fire is reported in sec. 11, T. 40 N., R. 10 E., and fire fighters have to come from Glacier Ranger Station. How long will it take them to reach the fire? By what route of travel would you send them?

3. A small fire is 33 feet wide on the north side, 330 feet long on the east and west sides, and 66 feet wide on the south side. What is the area in acres and how did you arrive at the answer?

4. You are acting as dispatcher and there are three small fires reported at the same time, in green timber, one each in secs. 1, 24, 31, T. 39 N., R. 8 E. You have available to send at once three CCC men, inexperienced, and three regular trail men who are experienced fire fighters. What men would you send to each fire? Would your action be any different or would you take any further action if the fire in section 1 was in an old burn with many snags?

To my mind the telephone is one of the best devices in guard training if put to its fullest use. A trip to a remote lookout may take 2 days' travel for a few hours' training; whereas, if you have 15 minutes to spare, you can be in contact with the man by telephone in a few seconds. With the telephone 99 percent of the available time may be spent in training; whereas, in a trip to the station 80 percent of the time may be spent in travel and only 20 percent in actual training. Trips to the guard's station should not be abandoned, however, as these contacts stimulate the guard and make him feel that he isn't a forgotten point on the map not important enough for a visit from the ranger. Also, it is not possible to see over a telephone a disorderly station or a poorly kept fire cache, or vice versa, for criticism or compliment.

A CHECK ON FIRE PREVENTION METHODS

G. L. FRASER

Fire Protection Officer, Region 5, U. S. Forest Service

The author is a specialist in charge of fire-law enforcement in Region 5, where experience has shown that heavy emphasis on fire-law enforcement is vital. The effect of such aggressive enforcement needs to be analyzed and measured in every possible way. In no other way can we determine how much of the good of fire-law enforcement is nullified by the ill will and harm which it may engender. The effects of aggressive fire-law enforcement everywhere might well be checked by the methods outlined by the author. Where weak law enforcement prevails, comparable checks to determine the wisdom of that policy should be equally valuable.

Lighting, maintaining, or using a campfire upon any brush, grass, or forest-covered land which is the property of another between April 15 and December 1 of any year without first obtaining a written permit from the owner, lessee, or agent thereof is comparable to hunting without a license in California.

Our fire trespass regulations with respect to the control of campfires are quite adequately supplemented by section 384 of the California Penal Code, which specifically requires a written permit either from the owner of the land or from the Forest Service before camp or other fires may be legally started or maintained on areas as defined.

The Forest Service permits are issued free, and require the signature of the applicant agreeing to the certain provisions with respect to the building of campfires, careful use of tobacco in the woods, carrying of shovel and ax, etc. Special circular instructions provide that forest officers or other issuing agencies must require permittees to read the conditions set forth thereon before signing and accepting the permit.

During the 1937 fire season approximately 400 minor fire cases were initiated for prosecution in the State courts. A large proportion of the cases so initiated resulted from violations of the campfire permit provisions.

After the close of the fire season, a representative sample of the people who had been cited for these minor infractions of the fire laws were interviewed at their homes for the purpose of learning, if possible, just what their general and specific reactions were to the prevention methods applied. Much to our satisfaction we learned that in almost every instance the people interviewed were, notwithstanding the penalties assessed, in sympathy with and cognizant of the necessity for strict regulations in connection with the proper and careful handling of campfires designed to prevent disastrous and destructive forest fires.

The most specific unfavorable reactions seemed to center around what in some instances were termed excessive fines for first unintentional offenses. In some cases these fines ran as high as \$25 which, when deducted from vacation allotments, necessitated the curtailment of full time vacation periods.

In most instances where fines of \$10 or less were imposed, the principal complaints were to the effect that had the violators known it was unlawful to leave a campfire smouldering while fishing, boating, or hiking for short periods, the violations would not have occurred. This, of course, can be attributed to carelessness from two sources, coupled with possible lack of candor on the part of the permittee:

1. Either the forest officer or other agency issuing the campfire permit neglected to follow instructions requiring the permittee to read the conditions thereon before signing and accepting the permit, thereby overlooking one of the most effective prevention measures within our reach.

2. The permittee was not entirely honest in claiming that he had not read or been required to read the permit before affixing his signature.

The remedy for the first source of carelessness can, of course, be found in the performance record of our own people; while in the second, when we can be reasonably sure that the permittee is not entirely honest, we should have no hesitancy in enforcing the restrictive measures provided.

In all instances, we were advised that the forest officers who visited the camps on their daily patrol or inspection trips were friendly and courteous in every respect, but in many cases it was brought out that they failed to stress the importance of compliance with the provisions of the permits or to inquire if the permittee was thoroughly familiar with the terms thereof. Here, again, if this is true, splendid opportunities for effective prevention work are being dissipated.

Steps are being taken in our prevention campaigns to get the most out of the lessons learned and to benefit from what the violators reported.

STERILIZING SOIL WITH CHEMICALS FOR FIREBREAK MAINTENANCE

H. D. BRUCE

*Chemist, California Forest and Range Experiment Station,
U. S. Forest Service*

It is a common belief that chemistry could be drawn upon for important aid to fire control. Experiments starting in 1911, however, have failed to realize very fully on the apparent possibilities of such aid, but in this article there is presented one important and promising development.

A firebreak, after being cleared of trees and brush, soon reseeds to annual vegetation. Although this does not entirely destroy the usefulness of the break, it does reduce its value for quick and strategic backfiring. For this purpose it has become the practice each year to



Spreading dry arsenic trioxide powder upon firebreaks. Two workmen can treat a 5-foot strip previously cleared of vegetation at the rate of 1-1½ miles per hour.

clear a narrow strip through the annual cover. While this can be done rather cheaply where topography permits operation of tractors, on steep breaks expensive hand labor is necessary. In any case, such clearing is only of temporary value and preliminary work must usually be done before breaks can be fired.

Investigations of the possibility of increasing the permanence of backfiring strips by sterilizing the soil have been conducted for several years. Although the effects of a number of industrial chemicals, in various concentrations on various species were studied, only a few were sufficiently effective and at the same time inexpensive enough to warrant their use. Of these, inorganic arsenic is superior. It is relatively cheap, readily available, and extremely toxic.

Arsenite has the remarkable property of becoming almost insoluble in the soil. Even though it be applied in the form of a solution, once it strikes the ground it is absorbed by the soil colloids so that it seldom



The 5-foot trail of white arsenic left by the applicator. The trail will remain white until the first rain.

reaches deeper than the first inch or two. It is, however, available for imbibition by roots. Shallow roots of grasses and herbs are thus killed and sprouting seeds never develop.

Arsenic is preferably applied in the form of white arsenic trioxide As_2O_3 . To spread this as a dry powder, a mechanical applicator has been constructed. It consists of a hopper on wheels, of capacity ample to accommodate 100 pounds of white arsenic. Inside the hopper is a brush, 5 feet long, which rotates as the machine is drawn along, evenly distributing the powder through perforations in the bottom. With this machine, several miles of trail can be treated daily.

For adequate sterilization in the sandy soils of the Sierra Nevada, the optimum spreading rate is about 4 pounds of arsenic trioxide per square rod of surface area. For heavier soils and heavier rainfall, this rate should undoubtedly be increased.

A trail of white arsenic is left in the wake of the applicator. If no maintenance be done on this break in succeeding years, the white



A firebreak trail, sterilized with 4 pounds of white arsenic per square rod, still barren after 3 years.

trail becomes a bare mineral pathway with dense grass and brush on either side.

Arsenic trioxide is only slightly and slowly soluble; hence, it is slow acting. It will not kill grass established at the time of application; therefore, it should be in the soil before the seeds begin to sprout. For this reason the apparent effectiveness of arsenic trioxide as an herbicide is often not as great the first summer as it is the second and succeeding seasons.

Arsenic in its surface-sorbed state will not ordinarily kill deep-rooted perennial species. These should be removed prior to the arsenic treatment. If they cannot be satisfactorily uprooted, as is the case with a sprouting shrub like bear clover, chemicals may be profitably used. Sodium chlorate is excellent for this purpose. Unlike arsenite, chlorate remains soluble in the ground and easily leaches down to the level of deep roots. Sprinkled dry or dissolved, at the rate of 4 pounds per square rod, sodium chlorate in one application will penetrate the roots and kill all the bear clover in the treated area. The first rains completely remove this chemical from the top soil layer, in which seeds may again sprout, and grass and herbs flourish. Accordingly, to



A backfiring trail through bear clover, treated with sodium chlorate and arsenic trioxide, still, quite barren after the third year.

reduce the soil of a stand of bear clover to complete barrenness, both chlorate and arsenite would be used, the former to kill the bear clover, the latter to inhibit the growth of annuals.

A 5-foot backfiring trail through a dense stand of bear clover was treated with 4 pounds of sodium chlorate plus 4 pounds of arsenic trioxide per square rod. Now 3 years after treatment there is neither bear clover nor grass on the treated ground.

The economic value of soil sterilization depends upon its period of effectiveness. Just how long vegetation will be kept from growing on soil treated with 4 pounds of arsenic trioxide per square rod cannot be definitely stated. It depends largely on chance factors, such as

wind and water erosion, treading by horses, cattle, and men, and burrowing by ground squirrels, as well as chemical fixation in the soil and leaching by rain water. In light sandy soils the effective period is longer than in heavy loams and clays. Small fenced experimental plots over 5 years old are still sterile. Having lasted 5 years, the sterilization may last 10.

Although the prime purpose of sterilizing soil on firebreaks is the establishment of a backfiring line, another purpose is cheap firebreak maintenance. To distribute 4,000 pounds of arsenic over 1 mile of 50-foot break by hand labor would cost about \$170 for men and materials. Assuming a 10-year duration, this means about \$17 maintenance cost per year per mile of 50-foot break. This may be compared with maintenance costs in southern California variously estimated at from \$120 to \$275 per mile.

On some firebreaks, backfiring trails are cut annually with a disc harrow, the cost of which is about \$8 per mile. To spread arsenic on the harrowed trail would cost an additional \$15. But, if the \$23 thus expended would last 10 years, the annual maintenance cost would approximate only \$2.30.

It is generally acknowledged that, under some conditions, firebreaks form an essential part of forest-fire-control facilities. In many cases their strategic use can be increased and their cost of maintenance can be diminished by rational use of soil-sterilizing chemicals.

Arsenic is better recognized as a poison to animals than to plants. If animals eat enough arsenic, they die; if arsenic is spread upon grass which is later consumed by cattle or deer, fatalities may result. However, in our use of this poison on firebreaks, the cover is first removed, then the poison is spread on mineral soil. White arsenic is an oxide with little, if any, taste or odor. In these respects it differs from the sodium arsenite which has a salty taste or sodalike odor and which has proved attractive and disastrous to grazing animals. White arsenic has been applied in cow pastures and deer refuges without the animals showing any signs of curiosity or ill effects.

Men working with arsenic powder must avoid breathing its dust and after each working period should clean carefully beneath the fingernails and wash all dust from the hands and face, lest arsenical skin sores develop.

In addition to the poison hazard, there may be other difficulties. One of these is erosion. Removal of the grass cover by burning, rather than by harrowing, scraping, or dragging, the installation of simple erosion dykes, and the studied location of the sterilized trail will do much to lessen the danger of erosion. Other difficulties are wind and runoff. If a strong wind or torrential rain occurs soon after distribution of the arsenic powder, it may be washed or blown away before becoming fixed in the soil. As a precautionary measure, spraying the treated strip with water following the application of the arsenic powder may sometimes be desirable.

TRACTOR USE IN FIRE SUPPRESSION

P. D. HANSON

Fire Control Planning, Region 5, U. S. Forest Service

All our fire-control machines and tools are in ceaseless competition with each other. One such competition is between the tractor-trailbuilder and the tractor-brushbuster. Region 5 adheres to the tractor-trailbuilder, and year by year makes increasing use of this machine. Region 6 uses the tractor-trailbuilder extensively, but, in addition, has developed the tractor-brushbuster, which is designed primarily for clearing brush, young growth, and debris rather than for digging a fire line to mineral soil. Whether both machines will find a permanent place in fire control or whether one will give way to the other remains to be decided by competitive test and experience. The author reports 1937 progress made with the tractor-trailbuilder in his region.

Tractors were first used in fire-line construction in Region 5 in 1926, when machines of the 60 hp. caterpillar type were used to drag churn-butted logs or graders around the perimeter of the fire. In 1931, the development of the trailbuilder attachment resulted in a complete line constructing unit in itself and eliminated the need for using logs, drags, or graders. This attachment on lighter weight machines also helped to solve the transportation problem, as these lighter units could be readily moved about by truck.

Since 1931, there has been a gradual increase in tractor use in fire-line construction on several of the forests in Region 5. In 1936, the Shasta Forest alone built 38.7 miles of fire line, or an average of 4.3 miles on each of the 9 fires on which tractors were used that year.

In 1937, the region felt it was advisable to make available tractor units with trailbuilder attachments solely for fire suppression purposes. Accordingly, 13 units, consisting of 3 Cletrac 55's, 6 Cletrac 35's, and 4 Caterpillar R-5's, with suitable transportation facilities, were stationed at strategic points throughout the region and held in readiness for fire call. One of the Cletrac 35's was equipped with a water tank of 140 gallons capacity, water pump, and hose. These 13 tractors were made available for the period June 1 to October 30, at a total rental cost for tractors and trucks of \$4,400.

In addition to the tractors provided solely for fire-suppression purposes, other machines, some of which were rented from private operators and others which were operating on Forest Service improvement projects, were used for constructing fire lines in suppression during the season.

The 1937 fire season was noted for its relatively low percentage of class C fires. Only 73 out of a total of 1,505 fires, or 4.8 percent, were 10 acres in area or over. Consequently, tractors were not called into use to the extent that they would have been in previous seasons had they been available. However, they were used on a sufficient number of fires to warrant a study of their effectiveness and cost.

In addition to their use on actual fire-line construction, these tractors also contributed materially to other fire-suppression activities, some of which were:

Reenforcing and widening hand-made corral lines.

Assisting in mop-up, which included pulling down and removing snags, pushing in burning chunks, ditching, digging out burning stumps, etc.

Opening up and building roads to enable camps to be established nearer the fire or to provide transportation of men by truck nearer to the fire line.

Hauling water on sleds to the fire to supply back pumps.

Opening up or building roads to and around the fire to enable water-tank trucks to reach the fire line and assist in control and mop-up.

Since there was a marked difference in the cost of maintaining tractors for fire use only, compared to the cost of utilizing other machines for suppression work, the accomplishments and costs of each class have been kept separate. Table I shows the use to which the tractors were put and the production in chains per hour, cost, estimates of man hours required to duplicate the work, and other related data.

Table I

Description of tractor use	Private and improvement tractors	Fire stand-by tractors	Total all tractors
1. Number of fires on which tractors were used.....	12	8	20
2. Total fire perimeters (chains).....	2,927	1,978	4,905
3. Fire line constructed by tractors (chains).....	727	827	1,554
4. Percentage of total fire line worked by tractor.....	24.8	41.8	31.7
5. Time to construct fire line (tractor hours).....	77.8	92.5	170.3
6. Rate of construction per tractor hour (chains).....	9.3	8.9	9.1
7. Cost per tractor unit hour. (All costs including labor and rental prorated against actual working time for season).....	\$13.22	\$35.60	\$22.90
8. Cost per chain of fire line constructed.....	\$1.41	\$3.99	\$2.51
9. Estimates of manpower equivalent chains per man hour (considered optimistic).....	.21	.66	.32
10. Estimates of manpower saved (man hours).....	11,490	5,770	17,260
11. Number of men equivalent to one tractor unit in line construction.....	45	14	29
12. Conservative estimates additional burned area prevented (acres).....	1,135	1,155	2,290
13. Fire line used as roads. Permitting tank truck mop-up (chains).....	156	191	347
14. Other roads constructed (chains).....	425	10	435
15. Time to construct these roads (tractor hours).....	55	2	57
16. Used other activities (tractor hours).....	37	35	72
17. Average number of men in tractor crew.....	3.2	2.8	3.1

From general descriptions of the fuels in which fire line was constructed, the season's experience indicates what may be expected in line production by machines of different sizes in the resistance-to-control fuel classes as follows:

The larger tractors, such as the Caterpillar RD-8 and RD-7 and the Allis-Chalmers 75, showed a range in line production from 7 chains per hour in extreme resistance fuels to 35 chains per hour in the moderate resistance fuels.

The medium sized tractors, represented chiefly by the Cletrac 55, produced line at the rate of 11 chains per hour in the high resistance fuels and 30 chains per hour in fuels of moderate resistance.

The Cletrac 35 produced line at the rate of 4 chains per hour average in the high resistance fuels and 10 chains per hour in fuels of moderate resistance.

The small Cletrac 15 produced 65 chains of line in low resistance fuels at the rate of 130 chains per hour.

The figures appear to indicate that the larger machines are the more effective in line construction, and appear to contribute more as the resistance class becomes more difficult, if they can be placed on the fire line. The main obstacles to their use are transportation and bridge limits.

Since the degree of slope is an important factor in the effectiveness of tractors in fire-line construction, an effort was made to collect information on the maximum practical limits in slope which various machines can negotiate effectively. Information secured on the Caterpillar Diesel models is included in the following list:

1. Nearly any standard make of track-laying tractors can negotiate slopes up to 35 percent, terrain and vegetation permitting, and up to this limit can work effectively either up or down the hill, quartering up or down the hill, or working across the slope, or parallel with the contour.

2. Caterpillar D-7 and D-8 will climb up a 45 percent slope. Caterpillar D-6 will climb up a 50 percent slope. Caterpillar D-4 will climb up a 55 percent slope.

3. The element of danger enters rapidly in descending slopes approaching 60 percent and over.

4. The wide gage model machines, with track shoes 2 inches wider than the standard furnished, are recommended.

5. The hill-climbing ability of the Caterpillar D-4 tractor is explained by the fact that this machine has less weight per drawbar horsepower than the other machines mentioned. The use of this machine will be experimented with further.

The economy in use of tractors in fire-line construction alone is evident when one compares the cost range, as shown in table 1, with the average regional cost of line construction by hand, which analysis shows exceeds that of the tractor by 200 to 300 percent. Significant, also, is the rate of line construction and the additional contribution of the machines to the efficiency in execution of many other parts of the fire-suppression job.

The relative economy of and justification for more universal use of other Forest Service improvement and privately owned machines is evident. Lack of suitable transportation is the chief reason which limits this use. There is a justifiable need for at least one large fast truck on each of the fire forests.

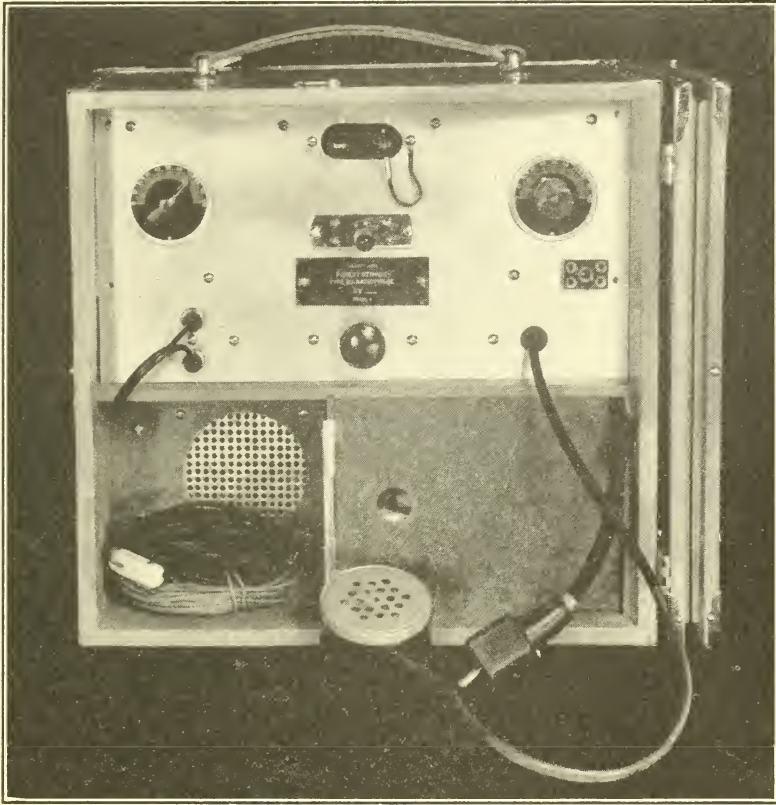
Planning in connection with the use of tractors in fire suppression should be directed toward identification of areas where these machines can be used, and the preparation of maps showing these areas, segregated by slope classes, recognizing the limits between 0 to 35 percent, and 35 to 55 percent. This information, supplemented with maps showing resistance to control-fuel types and the occurrence of C fires, should prove a strong basis for distribution of machines and should be an aid to dispatching action.

RECENT ADDITIONS TO FOREST SERVICE RADIO EQUIPMENT

A. G. SIMSON

Radio Engineer, Region 6, U. S. Forest Service

Since the various types of Forest Service radio equipment were described in Mr. Simson's article, "Forest Service Radiophone Equipment," page 197, Fire Control Notes, April 1937, two new pieces of apparatus have been developed. The new radiophones are described



Type SV ultra-high frequency radiophone.

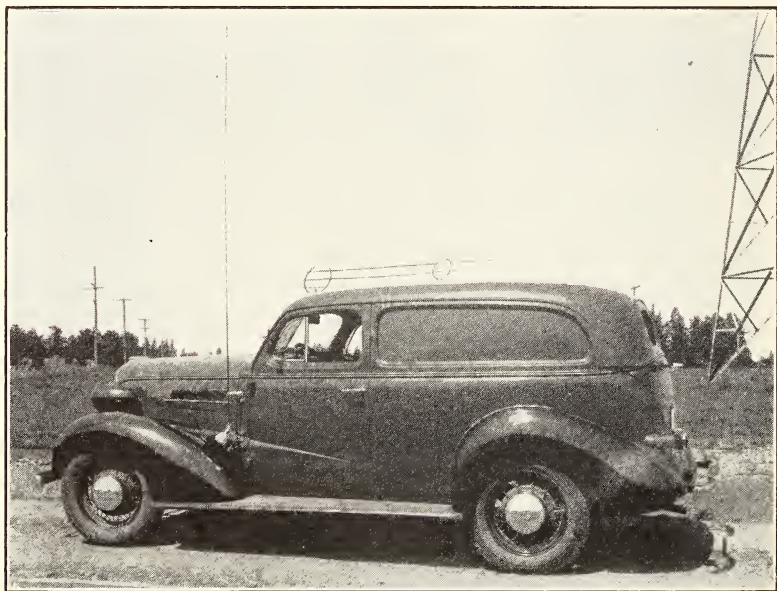
in this article. Requisitions for Forest Service radio equipment and correspondence on technical matters should be addressed to: Regional Forester, Box 4137, Portland, Oreg.

Type SV Radiophone (UHF)

The type SV radiophone is a larger and more powerful adaptation of the type S radiophone. Where the additional weight and bulk do not preclude its use and the extra cost can be borne, it offers several marked advantages over the type S.

The type SV transmits and receives voice only, and is intermediate in power between the types S and T. The estimated working range may vary from 80 miles between mountain lookouts to as little as 3 or 4 miles under certain level-ground conditions. Independent transmitting and receiving sections are mounted on the same chassis, which completely eliminates the frequency shifting between transmit and receive which is necessary in type S. A loudspeaker only is provided on the receiver. The same antenna is used for both transmitting and receiving. A special method of coupling permits a wide variation in the types of antennae employed.

For medium duty or intermittent service all batteries are contained in the set cabinet. Heavy-duty batteries for continuous operation may be attached externally by means of a special cable, which,



Mobile antenna installation showing method of mounting.

however, must be ordered as an accessory item. Weight, complete with medium duty batteries, $18\frac{1}{2}$ pounds.

Type I Radiophone

The type I radiophone is a condensed and simplified unit intended for operation on 6-volt storage battery only, and transmits either voice or cw telegraphy. The power output of the I-type transmitter is intermediate between that of the types SPF and M. Normal output power is approximately $9\frac{1}{2}$ watts.

This device is supplied in individual units—receiver, transmitter, and transmitter power supply. For semiportable operation these units are grouped into a single mounting cabinet.

Type I is primarily designed for mobile installation in cars or trucks, and the various units may be distributed under the dash or in other locations to take advantage of available space. For mobile operation the receiver supplied with the type I is similar

in appearance to a conventional automobile radio receiver. It is equipped with a very satisfactory system of push button tuning which may be mounted near the steering column of the vehicle.

When ordering the type I, specify whether for semiportable or mobile installation. If for mobile use, give make and year of car so that a suitable receiver tuning head may be supplied. When supplied for mobile operation a special rod-type antenna will be furnished with the necessary tuning box for mounting on fender or bumper of car. The type I will be supplied to transmit and receive voice only when ordered for mobile service.

The range of the mobile radiophone varies from an estimated 25 miles under unfavorable conditions to as much as several hundred miles under favorable conditions. Probably the range is comparable to that of a type SPF radiophone using kitbag batteries and antenna.

EMERGENCY WIRE REEL

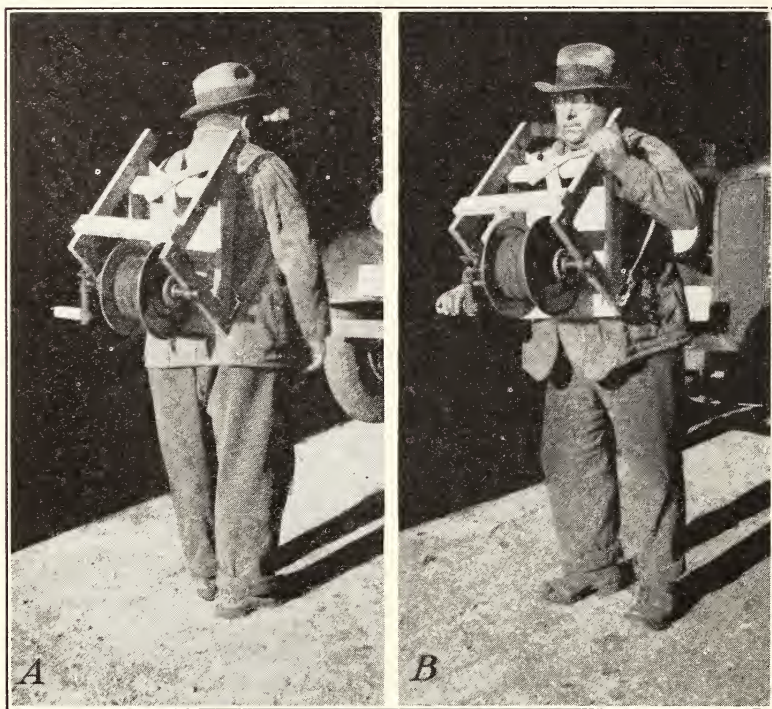
JACK GILMAN

District ranger, Lassen National Forest, U. S. Forest Service

In order to pay out and take up emergency wire without breaking or wearing it out, a reel was constructed back in 1933, which has since been used successfully on numerous fires. One man can reel out or reel in the wire as fast as he can walk.

When paying out wire, the reel is worn on the back, the loose end is secured, and the man simply walks to his destination reeling out the wire as he goes. When taking up the wire, the reel is worn on the chest or stomach, the man travels toward the other end of the wire turning the crank and reeling up the wire as he walks. The wire is not dragged in either operation.

The unit which holds the spool consists of $\frac{3}{4}$ -inch pipe, 90° elbow,



Emergency wire reel in use: (a) Back view, (b) front view.

and wooden handle. To the shaft are welded three washers, two to prevent side play in the frame and one to support one end of the spool. The spool of wire is placed on the shaft out of the frame. The end of the pipe is threaded to take a $\frac{3}{4}$ -inch floor flange which is used as a lock nut to keep the spool from turning on the shaft.

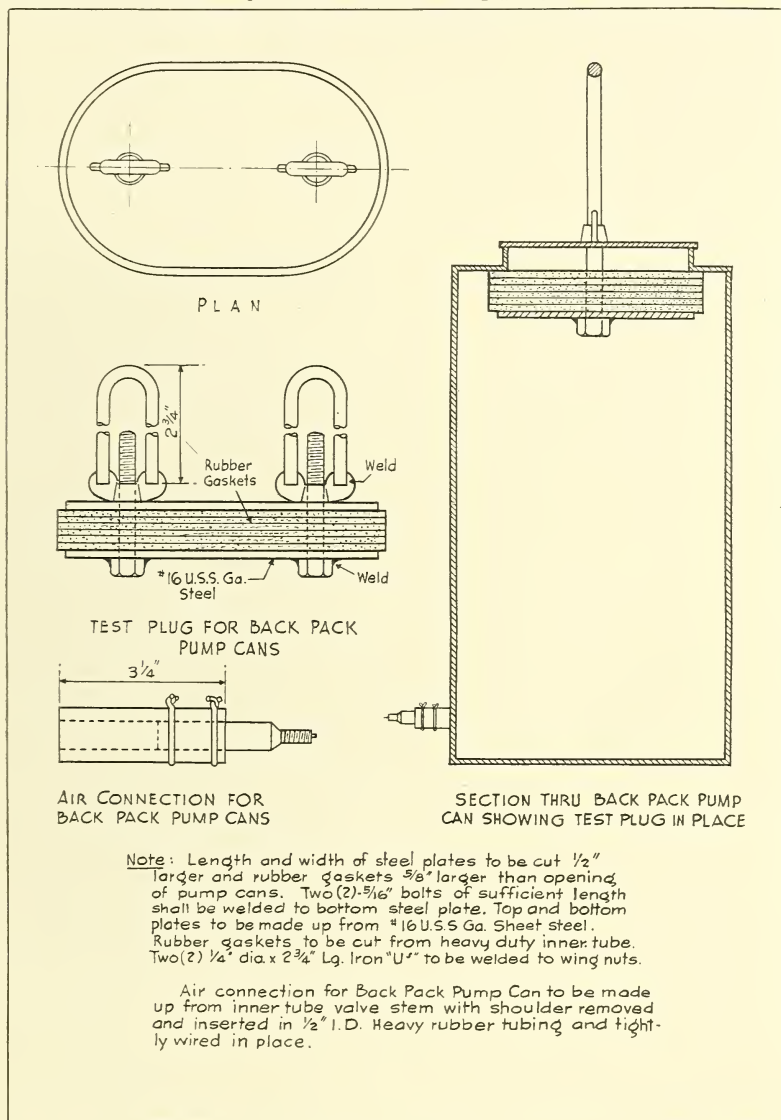
The shaft unit is supported by a wooden A frame attached to a pack board with straps. In one side of the frame there is a hole into which the threaded end of the shaft is placed, and a slot on the other side for the shaft to be secured in place by a pin and iron straps similar to a barrel lock.

TESTING BACK-PACK CANS FOR LEAKS

FOREST PROTECTION DIVISION

Wisconsin Conservation Department

A valve for making the top of the can air tight, and an air valve, such as an auto tire valve, which may be inserted in the can and attached to an ordinary air hose for testing purposes, are the essential



Plans of can leakage tester.

items needed in order to test back-pack cans for leaks. Testing in this way has proved to be very rapid and efficient, particularly where there are large numbers of cans to be overhauled following a large fire or a heavy season's use.

HANG-OVER LIGHTNING FIRES

C. D. BLAKE

*Assistant Forest Supervisor, Flathead National Forest,
U. S. Forest Service*

To those who do not know the job, it is a constant wonder that lookout men get azimuth readings on lightning strikes as well as they do, particularly at night. Even so, the average record lacks completeness and precision. Anything that will make for greater accuracy is, therefore, of high importance. The author suggests a device by which lookout men may get a rough but useful measure of the linear distance to such strikes.

The high percentage of hang-over lightning fires, like an unconquered bugaboo, continues persistently from year to year to smirch our fire-control achievement records with unsightly blots.

The main trouble appears to be our inability to locate accurately fire-setting lightning strikes in order that they may be searched out



A flash of forked lightning which confused four experienced fire-control men.

and squelched without the alarming elapsed discovery time which is so common. Even the experienced observer finds that too often the blinding lightning flash prevents accuracy of location. Camera records convince us that too often the human eye detects only a small percentage of simultaneous strikes to ground. Too often the lightning flashes come too thick and fast to permit even the experienced man to record more than a small percentage of the strikes to ground. If this is the case with the experienced observer, is it any wonder that the (probably badly frightened) inexperienced man fails?

I recognize my inability to offer a satisfactory solution to this important problem in fire control. I do know from experience that the old scheme of attempted location of lightning strikes by azimuth triangulations from two or more observation points is very unreliable.

Admittedly, in the following proposed substitute method for lightning-strike location there are possibilities of error because of optical illusions. However, if given a fair trial, I am certain you will discover it has advantages over the old scheme, and may be improved on. At least this plan permits observers to try independently for strike locations. Here it is:

Upon the approach or formation of an electric storm prepare yourself with fire finder or a sight compass. When a lightning strike appears, direct the sights of the instrument on the location and determine the period, in seconds, between the flash and the sound of thunder. Since sound travels a mile in approximately 4.5 seconds, the distance may be determined by dividing the period in seconds by 4.5 or 5.0. (Use 4.5 if wind blows toward you from the strike and 5.0 if it blows away from you.) The strike location may be determined by scaling off on the map the direction and distance. A stop watch is recommended for recording the interval between the flash and the sound of thunder. However, the period may be ascertained in seconds by counting, beginning with 1,001, 1,002, 1,003, etc., then by dividing the last three numerals by 4.5 or 5.0.

REGION 6 FIRE-DANGER BOARD

DONALD N. MATTHEWS AND J. F. CAMPBELL

U. S. Forest Service, Portland, Oreg.

In each district ranger's office in U. S. Forest Service Region 6 (Washington and Oregon) is a fire-danger board which strikingly

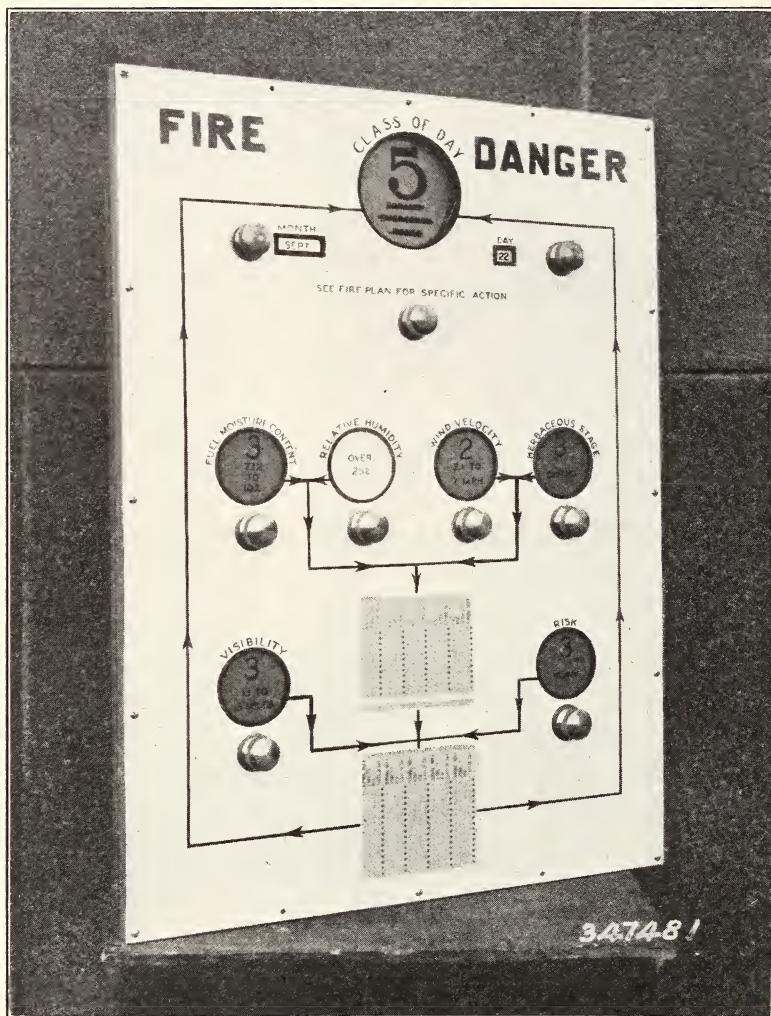


FIGURE 9.—The Region 6 fire-danger board.

summarizes the variable factors of fire danger and combines them into class-of-day ratings. Although a few experimental boards were on trial in 1936 their regular use was started with the 1937 fire season. The fire-danger boards and the rating system were developed by the Pacific Northwest Forest Experiment Station collaborating with the regional fire-control office.

The fire-danger stations are the source of information used in "posting" the boards which the rangers use in determining presuppression action. These are located at guard stations where fuel-moisture-indicator sticks (called "fuel sticks" for short), wind gage, psychrometer, and herbaceous-stage plots are used to measure fuel-moisture content, wind velocity, relative humidity, and herbaceous stage, respectively. In addition, Byram haze meters are used to measure visibility conditions; i. e., radius of vision, from certain selected lookout points. Ocular estimates are made at other points.

The fire-danger boards are 18 by 24 inches in size, made of metal. Each factor of fire danger used on the board is divided into classes, and each class is assigned a color. Fuel-moisture content, as measured by the fuel-moisture-indicator sticks, for example, is represented by classes and colors as follows: Class 4, 0 to 7 percent, red (this is the most dangerous condition); class 3, 7.1 to 10 percent, orange; class 2, 10.1 to 18 percent, blue; class 1, 18.1 to 25 percent, green; and class 0, above 25 percent, white. Corresponding classes of all factors have the same color; that is, class 4 is always represented by red, class 3 by orange, etc. Large class numerals (4, 3, 2, etc.) in black and the color of the current condition of each factor are displayed through an opening in the board by turning a knob attached to a disk mounted behind the face of the board. A glance at the board may show red, 4 (a large black 4 on a bright red background), fuel moisture; red relative humidity; green, 1, wind velocity; red, 4, herbaceous stage; blue, 2, visibility condition; and orange, 3, risk existing on the district.

All these factors are combined, by means of two simple integration tables on the face of the board, to produce one of seven class-of-day ratings. As a final operation the class-of-day numeral (7, 6, 5, 4, etc.) in black on an appropriate colored background is displayed in a large opening at the top of the board by turning another disk.

Fuel-moisture content, relative humidity, wind velocity, and herbaceous stage have a place on the board because they determine how fires will burn.

Fuel-moisture content is measured by means of fuel-moisture-indicator sticks, used in sets of three. They are one-half by one-half inch ponderosa pine sapwood sticks containing 100 units (grams) of oven-dry wood. Their weight (in grams) indicates their moisture content without any computations. (Simple, low-cost scales have been devised to weigh these sticks.)

The fuel-moisture-indicator sticks are continuously exposed in the open under the same forest-cover conditions as the fuels that are typical of each locality. They indicate the cumulative effect on fuels of the interplay of all weather elements—relative humidity, temperature, wind, rain, etc.

The herbaceous-stage factor is an estimate of the current fire-danger status of the annual growth of vegetation, such as grass, ferns, and weeds, made on plots staked out in representative areas. When the annuals are green and succulent, they do not add to the fire danger, but may be a retardant. As the season passes and they become progressively drier, they add materially to the fire danger. The effect of this vegetation on fires varies greatly at different periods of the fire season and on the same date in different years. The

estimates on condition of the herbaceous plots furnish a practical means of weighing this factor in rating current fire danger.

Fuel-moisture content, relative humidity, wind velocity, and herbaceous stage are combined in a single integration table on the face of the board to produce a burning index. This burning index is concerned only with those factors of fire danger which vary markedly during the fire season. For example, although the kind and the quantity of fuel varies from place to place and may be of major importance in determining what a fire will do when burning conditions are dangerous, these factors remain practically constant, except as taken care of in the herbaceous-stage factor on the board, and are not considered among the variable factors combined in the burning index.

Having obtained the burning index from the burning-index table on the board, the next step is to determine the total fire-danger condition in order to decide what action should be taken—how many lookout men, smoke chasers, and patrolmen are needed. In order to get this, visibility conditions (the distance lookout men can be expected to see the smoke from a small fire) and risk (the relative activity of the fire-starting agencies such as man and lightning) also have a place on the board. These two factors of fire danger are combined with the burning index in a second table, and produce one of seven class-of-day ratings that are used to determine the pre-suppression action that will be taken to meet the fire-danger conditions that produced the rating.

Each district ranger prepares a fire plan at the beginning of the fire season which stipulates in detail the action he will take to meet each class of day. The fire plan is the connecting link between the rating of fire danger and administrative action. Although its striking color scheme makes the board the showy feature, nevertheless the ranger's fire plan is the heart of the system because it gives it life and action. It indicates the specific action the ranger will take to meet each class of danger. For example, his plan will list by name the positions to be manned—lookouts, patrols, etc.—and other action to be taken to cope with each class of day.

The fire plans are localized because they are made for each individual district. They also provide an opportunity to incorporate provisions that action to meet any one class of day may vary somewhat depending on the factor—visibility, risk, etc.—which dominates the situation. Thus somewhat different action may be set up for a class 5 day caused by dry fuels and high winds than for a class 5 day caused by lightning.

The forest supervisor has a special fire-danger board in his office which shows the class of day reported on each ranger district. In the regional forester's fire-control office in Portland there is a master board which shows the class of day on each of the 100 ranger districts in the region. This master board consists of a large map of the region with a colored light at each ranger's headquarters to indicate the class of fire danger on each district.

MISSISSIPPI FIRE TANKS

VICTOR B. MACNAUGHTON

Fire assistant, Mississippi national forests, U. S. Forest Service

When the creative development of power-driven and other tools for fire control finally begins to slow down (if it ever does), it is more than probable that the crawler tractor will be playing an important role. In the October 1938 issue of *Fire Control Notes*, George M. Gowen reported one development in the use of water in California by means of the tractor. Here is testimony on the same point from a Gulf State.

Just as the thrilling cavalry charge in the military battles of 50 years ago is only a memory in the mechanized warfare of today, so the mass attacks of sheer manpower on fires in south Mississippi seems doomed to be replaced by mobile power units backed by small crews.

Twenty years ago at Ypres, the Hindenberg Line got a terrific shock when out of the misty smoke-filled dawn hundreds of British tanks advanced. Twenty years is a long time and it's a far cry from Ypres to the Leaf River battlefields on the DeSoto National Forest; yet, one afternoon in January, Mechanic "Slim" Sheffield rode into the smoke and flames behind the controls of a modern fire tank. The result on the enemy was comparable to that effected by the British tanks. Over logs, crashing through blackjack thickets, down hills, across swampy flats, always on the trail of the spreading fire line went the fire tank. Spewing a driving spray before it, the tank completely conquered flames 20 feet high backed by a 25 m. p. h. wind. Half a mile of line was conquered before it was necessary to refill the tank. Thus a new era of mechanized fire fighting was begun in Mississippi.

This fire tank solves the problem of direct attack on the head of a large grass fire. Heretofore, when backed by a strong wind, the head of the fire traveled until stopped by a backfire or natural barrier. Fire trucks are available on all national forests in Mississippi, and are very effective when they can be placed on the fire line. Their use, however, is limited by the topography, and usually they cannot reach the point where they are needed most.

This initial Mississippi fire tank was built at the Leaf River depot by Shop Foreman Sheffield, after a series of experiments and trials on actual fires. It does not represent the highest degree of possibilities, but its effectiveness on the fire line completely demonstrates the practical value of such a unit.

This first edition was built around a Cletrac A. G. 20 Tractor, on which are mounted two 100-gallon tanks. A power-driven hydraulic pump from a discarded dump truck drives the water under 100 pounds pressure through sprayers in front. The power take-off was made from discarded auto and tractor parts. The speed of this pump is approximately 1,500 revolutions per minute.

A by-pass valve, which is adjusted to the pressure desired, is built in line between the pump and nozzles. The two tanks are hooked together so that the pump draws evenly from both. A three-way valve, coupled in the suction line, permits the operator to refill the tanks in 12 minutes. The take-off that controls the pump so that it may be shifted in and out of gear is located under the driver's seat.

The spray attachment in front consists of a semicircular length of

pipe to which are fitted three sprayers. The unit is mounted with brackets near the top of the radiator and close to it. The bumper provides protection to the sprayer from bushes and trees.

A second spray attachment is located directly under the bumper. The water from these nozzles is directed straight down. This spray has separate controls and may be used or not as the occasion demands.

Twenty-five feet of high pressure hose is attached to the rear of the unit. This hose has a pistol-grip nozzle similar to the one used by automobile washers. If, because of some obstacle, it becomes necessary for the tank to veer off the fire line, that portion of the line can be suppressed by the hose operator walking behind the "tank." This hose is also useful to catch burning snags or logs which need immediate quenching. An extra section of hose is carried in case of emergency.

Transportation for the "tank" is provided by a 2-ton International truck. Upon arrival at the fire, heavy oak skids are pulled out and lowered to the ground. A sawhorse placed under the rear end of the body takes up some of the weight as the "tank" is driven down the skids onto the ground.

Conditions on the DeSoto National Forest in south Mississippi are especially favorable to the use of heavy power equipment. The land is gently rolling, offering no steep slopes to be climbed. Almost completely denuded of its mature timber a decade ago, the small blackjack, oaks, and young pine reproduction are easily ridden down by the fire tank. The light, flashy fuel cover of broomsedge grass yields readily to attack by water. A complete system of fine gravel roads insures fast travel to any fire. A number of these tractor units on each DeSoto district would tend to offset the loss in manpower brought about by the recent abandonment of CCC camps.

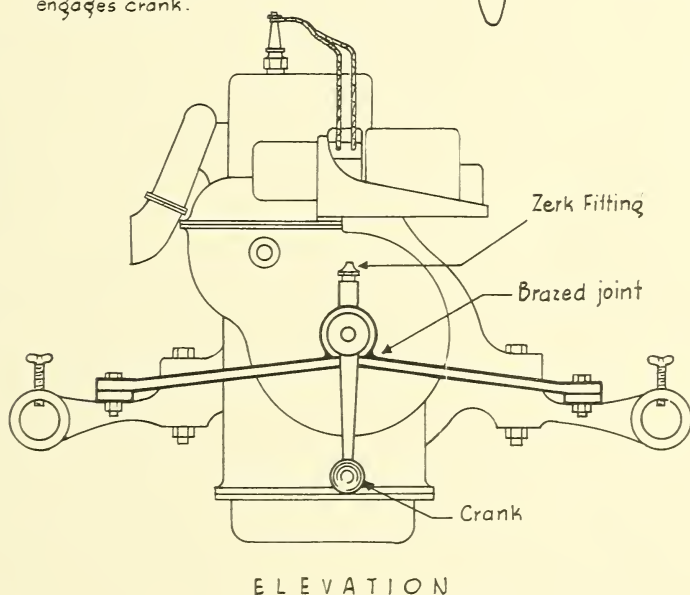
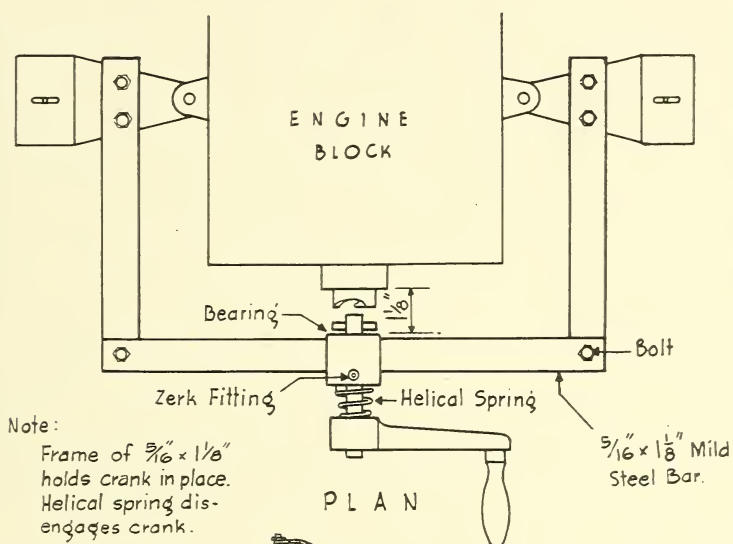
Some improvements planned for future models include more pressure, a more substantial pump, larger water tanks, a starter and lights for the tractor, and the use of mono-ammonium phosphate in the water tanks.

CRANKING DEVICE FOR PACIFIC PUMPER

Chippewa Forest, Region 9, U. S. Forest Service

The device shown in the accompanying sketch was designed for the four-cylinder U-Type Pacific pumper. It makes for easier and safer cranking and keeps the crank always in place.

The frame, made of $\frac{5}{16}$ by $1\frac{1}{8}$ -inch mild steel bar, is bolted to the front carrier supports, and extends around the front of the engine. The cross bar has a slight bend to line up the crank with the crankshaft ratchet. The crank bearing is brazed to the frame and a spiral spring is used to keep the crank disengaged. A fitting may be added to facilitate greasing.



Cranking device for 4-cylinder Pacific pump.

PRE-SEASON GUARD TRAINING ON THE HEBO DISTRICT

ROBERT AUFDERHEIDE

District Ranger, Siuslaw National Forest, U. S. Forest Service

Any time that two or more fire-control men gather together the topics of training and morale are sure to come up. The national forest replanning project gives high priority to both subjects, but sometimes it is hard to take hold of them effectively. Here is a district ranger who has tried a simple but excellent way of advancing both morale and training.

On February 20, 1937, while I was returning from the Oregon State Fernhopper banquet with four of the short-term force, one of the guards suggested a program of winter guard-training meetings. It was his idea that a weekly meeting, where the boys could discuss a problem or topic, would shorten the winter months as well as enable each man to prepare himself better for his job. As we discussed the idea, we became enthusiastic, and before we arrived home that night we had decided to give the idea a trial.

A week afterward I was attending the spring rangers' training camp so we did not hold our first meeting until my return. By this time our womenfolk had heard of the idea, and they decided they would also have a meeting—purely social. On April 9 we had our first meeting. The women gathered in the ranger dwelling and we met in the office. After a session of an hour or two, we joined the women and enjoyed refreshments and several hours of cards. We have had these meetings regularly ever since.

The Hebo district normally has 11 guard positions during the summer season. Of this number, two positions are ordinarily filled by forestry school students. One position is usually vacated each season for one reason or another, leaving eight positions filled by returning nonstudent guards. Three of these guards live at some little distance from the ranger station, and it is not very practical for them to be present at the meetings, although one guard frequently attends, traveling 35 miles to do so. Attendance has not at any time been requested or made compulsory in any sense. It is thoroughly understood that a man's standing is in no wise affected by absence from the meetings, and also that attendance in itself has no bearing on his holding his job.

On an average six regular guards and one emergency guard have attended. During spring maintenance several guards from distant stations are on the district, and our attendance is increased by their presence.

In 1937, because of our late start, only 6 sessions were held, but we have had 9 so far in 1938, and shall undoubtedly get in 12. Eighteen hours of additional training for one-half of the regular personnel is well worth while; at least, I have found it so.

One of my problems has been to secure well trained overhead for class B and small class C fires. My approach has been to secure sufficient emergency lookout personnel and train them, so that I could use regular lookouts for overhead positions on the smaller fires. Many evenings have been devoted to subjects pertaining to the efficient

handling of these fires—timekeeping, the camp-manager job, compensation, the foreman, tool man, etc.

At one of the meetings it was suggested that a brief reminder list might be of considerable assistance to men filling the overhead positions. We have developed that idea and have prepared a one-page reminder list for each job, arranged in a folder so that the list for each particular job can easily be torn out by the man filling that job. This folder is a part of each 15-man tool cache and is carried in the time-keeping kit.

Other subjects discussed have been the calculation of probabilities, public contact, the one-lick method of fire suppression, the proper preparation of Forms LE-1, fire fighters contract and time slip, a study of information necessary to complete Form 929, and trail and telephone maintenance standards.

The results and advantages have been numerous. From the standpoint of morale alone the meetings have been worth while. I believe that the fellows have a feeling that they are shareholders in the Forest Service; and where previously a guard may have worked only 4 to 6 months of the year, he now works for the Service continually. The spirit of teamwork seems to be more apparent. After several sessions on trail and telephone maintenance I noticed that a better and more efficient job was being done.

A meeting of this sort is a good place to put up a real problem, although it may sometimes be advisable to put it up as a hypothetical case. I've profited from a number of worth while ideas brought up in our sessions.

Several methods of training have been used, and I believe that a variation or a change of gait, so to speak, is very effective in sustaining interest and preventing monotony. We have had informal roundtables with everyone throwing in ideas and taking ideas from the pot. We have employed the conference method with a chart, and have used problems.

On occasions when we have made practical use of some of our acquired knowledge and training, it has been helpful to analyze and criticize our action constructively at our next session. We have even manufactured the occasions. After studying the one-lick method of fire-line construction, we took 30 Farm Security laborers assigned to us for trail work to a trail construction job and practiced the one-lick method with them, giving the guards the third and fourth steps of the four-step method. It was generally agreed that we gained in output of production on trail construction as well as benefited by the training.

The next topic I propose to take up is training instruction, with emphasis on the idea that much of our trouble in supervising a crew of men results from assuming that a man knows how to do some simple yet fundamental thing. If the boys can be taught to recognize this condition, better production on fire control and maintenance work should result.

As a result of the experience gained in conducting these meetings during the past two winter seasons, I expect to give more attention to the following points in planning future meetings:

1. Take sufficient time to prepare adequately instructional material.
2. Limit the subject so that it can be thoroughly covered in not to exceed a 2-hour period.
3. Vary methods of instruction and procedure in conducting meetings.

AUXILIARY RADIATOR COOLING SYSTEM FOR FIRE TRUCKS

W. R. OAKES,

Sequoia National Park, Calif., National Park Service

The simple system described by the author should be a ready means of curing heating troubles in engines which will not cool when being used to discharge a load of water while the truck is standing still.

In Sequoia National Park, where the California sun frequently produces temperatures well over 100° F. and where truck-trail grades run as high as 20 percent, the conventional motor-cooling system of the fire trucks is inadequate.

Several experiments were made with various methods of providing greater circulation of water. The most successful was to supplement the standard system by circulating water from the truck storage tank through the motor block and radiator and returning it to the storage tank by means of a small electric pump. The system is easy to install and no alterations to the truck or its standard equipment are necessary. Anyone handy with tools can do the job. Three-eighths-inch copper tubing was used to carry the water throughout the system.

The pump used to force the water from the storage tank was a Stewart Warner electric (6-volt) fuel pump, Model A-699. It was bolted to the dashboard under the hood, low enough to permit the water to flow by gravity from the storage tank to the intake of the pump as long as the tank was at least half full of water. A push-button switch was installed on the instrument board to control the supplemented cooling system in order to permit the motor to reach an efficient operating temperature, or to cut off the flow when the storage tank is empty. One wire is run from the hot post on the ammeter through the switch to the pump, the latter being grounded to the frame upon installation.

Flexible metal tubing was used to carry the water from the outlet of the pump to the drain plug connection on the radiator, the point where the standard system was cut off.

A spring check valve, ball bearing, was installed between the end of the flexible tubing and the drain cock to prevent the water from the radiator draining back to the tank when the latter is empty, or the loss of water in case of failure of the supply line. A return line of copper tubing was run from the overflow pipe of the radiator back to the storage tank.

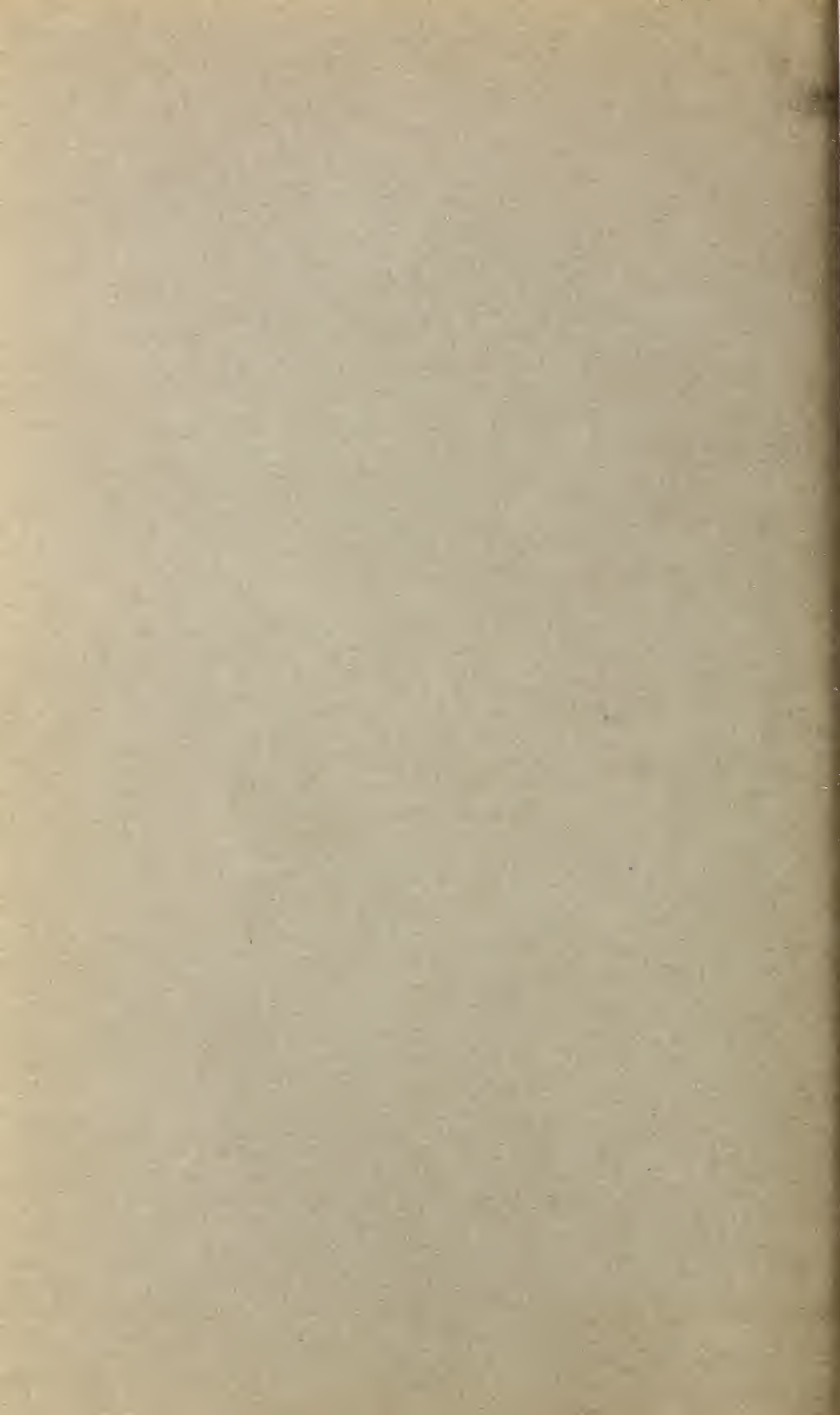
Since the fuel pump was not designed to pump water, the flat steel valve springs rusted quickly and were replaced with coiled brass valve springs originally designed for a mechanical fuel pump. (Flat brass springs could be substituted.)

The pump installed as described will deliver approximately 15 gallons of water per hour to the radiator. This has proved adequate for holding the water in the cooling system well below the boiling point.

The cost of the pump, tubing, and miscellaneous parts was approximately \$15 for each truck on which the system was installed. The installation can be used on practically any model and make of tank truck.

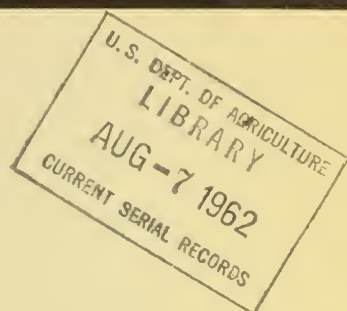


FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technology may flow to and from every worker in the field of forest fire control.



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A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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TRAINING OVERHEAD FOR SUPPRESSION WORK

LEE P. BROWN

Training Officer, Region 2, U. S. Foreign Service

Few people will disagree with the author's opening statement that executive errors have contributed to failure to handle large fires efficiently. Since most of our fire losses come from large fires, we might expect much thought and action to be focused on training designed to prevent such errors. The contrary is true if the 1937 index to FIRE CONTROL NOTES is a reliable mirror of thought. Under the subject of training there are but two entries. Radio, a tangible and relatively easy subject, boasts seven entries. Training is a dull and unimportant subject compared with airplanes, cooperation, and fire lines, according to the space used in FIRE CONTROL NOTES. The author converts this situation into a challenge to fire-control men. How can there be effective training for large fires until fire experts stop rushing from one thing to another long enough to digest what they know and agree on just what skills and mental habits should be emphasized in the training of men? The author does more than issue a challenge. He lays the subject out in such a way as to invite men who believe in the importance of training for big fire work to take a hand in developing a body of accepted ideas which training specialists can use.

Every conference of fire-control experts and every analysis of records of past fires emphasizes the fact that avoidable mistakes of personnel contribute, in some degree, to ineffective fire-suppression action on many large fires. Some of the personnel failures are the result of:

1. Mistakes in judgment—in timing, in planning, etc.
2. Failure to recognize potentialities.
3. Failure to function properly on the job because of inability to recognize place and duties in the fire organization.
4. Failure to see the job as a whole; this usually reflects inexperience.
5. Lack of administrative ability in organizing and directing crews.
6. Surrender to excitement, pressure, or fear.
7. Failure to apply knowledge of fire behavior, weather, etc.
8. Failure to adopt or combine techniques so as to secure the most effective action on fire.

Selection and Training

If the fire organization is to be strengthened and personnel failures minimized, there are two problems to solve. First, the selection of men; and second, their training. The two are inseparably linked. Training is essential to proper development, but the better the foundation the more effective will be the training. Training may supply props for deficiencies inherent in the men, but props may give way under strain.

It is desirable that men selected to be developed for overhead positions in handling fires have certain personal characteristics. Some of the more important are:

1. Indicated ability to plan and organize, and particularly ability to correlate.

2. Marked aptitude for administrative work.
3. Good health, particularly stamina.
4. Proved ability to work calmly and surely under heavy pressure.
5. Good analytical judgment coupled with a high degree of initiative, originality, and a perceptive imagination.
6. Qualities of leadership which inspire confidence and build loyalty.
7. Knowledge of the physical limitations (endurance) of the human machine, particularly one's own.

Men with a reasonable proportion of such qualities can be developed by training into efficient leaders for a fire organization. Any training program, however, must weigh the cost of training against the results secured. Although it may be possible to develop men with more or less fundamental deficiencies, the period of training is too long, the cost too great, and the assurance of satisfactory performance too uncertain to warrant the attempt. The first problem then, is to analyze the job and determine qualifications on which a training program can be built.

Methods, practices, and programs for training lookouts, guards, firemen, scouts, and fire fighters are well developed and in general accomplish the purpose for which they are intended. Detailed analyses giving the responsibilities of overhead positions, such as foremen, camp bosses, sector bosses, and fire chiefs on suppression work, have been made. One such analysis held a number of officers in overhead positions responsible for several hundred items, each under a number of general functions or operations. If these analyses are representative pictures of the job, perhaps we are asking for something that taxes human capacity too heavily. Certainly they indicate the need for a careful, systematic build-up of the officer's knowledge of his job and ability to perform on the job if he is to function surely and effectively on large fires. Are we tackling this training problem in the same way in which "guard training" has been made effective in increasing the efficient functioning of our primary protection forces; or are we, because of the exigencies of fire suppression work, training our overhead by the trial-and-error method? If we use the latter, should we not charge a reasonable proportion of the errors up to training and not condemn the inexperienced officer for his mistakes?

Overhead Training

In training overhead for large fire crews the major aims should be:

- (a) To develop the trainee's knowledge of fire behavior;
- (b) To instruct the trainee in different methods of fighting fire;
- (c) To develop judgment of the trainee in accurate appraisal of fire behavior and in applying fire-control methods in a practical manner;
- (d) To develop foremanship of crew leaders in handling men on the line;
- (e) To give the trainee a knowledge of what is essential to good organization of fire-suppression forces and an understanding of how officer should function to operate efficiently;
- (f) To develop the capacity of the trainee to organize, direct, and correlate the work of fire crews quickly and effectively (including the service of supply);

- (g) To instruct the trainee in the mobilization and demobilization of large fire-suppression forces, their supplies and equipment;
- (h) To develop the trainee's ability to recognize and appraise potentialities;
- (i) To develop the trainee's judgment and skill in planning ahead so as to be in the best possible position for meeting such exigencies as occur;
- (j) To give the trainee such guided experience and training that he will function confidently and surely under pressure on the job.

How can the instructor prepare himself for the job of training competent overhead for large fires? To what authorities and references can he turn?

In all the wealth of forest literature there is little on fire fighting that can be used as a text. One excellent, although brief, booklet on fire fighting is the one put out by the Western Forestry and Conservation Association. Another is the new Region 5 Fire Control Handbook.

Research has in its files a wealth of material on fire-suppression work, but little of it is available or usable for instructional purposes. The average officer who has to train or develop men for overhead positions on fires must rely for material largely on his own experience and his own habits or practices of fighting fire. He may be excellent in some phases, fair in others, and poor or inexperienced in a few of the tasks involved in a fire-suppression organization. The men cannot help but reflect the instructor's abilities and limitations. Under such conditions might it not be well to check up on the instructor as well as the officer who "blows up" in a fire organization?

So much for the general situation. The next step is to consider one by one the broad subjects indicated in order to get a better idea of how they should be handled in the development of an effective training program for overhead.

Fire Behavior

Research has made some study of fire behavior, but only a small part of its findings has been presented in such form that it can be used for instructional purposes. Fire-control men apply their knowledge of fire behavior, but have rarely analyzed fires in terms of topography, physics, meteorology, or ecology. Where, then, do forest officers get their knowledge of fires? The answer is by experience on fires. The observant and those inclined to experiment can learn pertinent facts on fire behavior from an evening campfire on the trail, from a pile of burning brush, from slash disposal fires of various kinds, as well as from forest fires.

Fire behavior on small fires is pretty well explained in guard training. But is fire behavior the same on large fires? If it is, how can it be predicted for large areas? If it isn't, what differences are there and how will they affect the task of fire control? When and where, for example, may an officer expect cyclonic drafts on a large fire? Frequent reasons for unexpected loss of line on large fires are that "the wind suddenly changed," or "a big wind came up and swept the fire over the lines." Only occasionally, however, do weather records

actually show any sudden, unusual, or material increase in wind velocities for that time of day. Has anyone ever tied the physical laws of gas or ether expansion to fire fighting? What combinations of topography, volume of heat, spread, weather, and the like may cause uncontrollable conditions? What indices may be used to foresee the approach of catastrophic conditions on the line? These are but a few of the questions a training officer must answer in developing and training officers on large fires. Your executive on a large fire must appraise fire behavior broadly; he cannot deal with it in minutiae. How can he be trained to do this?

Methods of Fire Fighting

Methods and techniques develop from experience. Only in the last few years have we heard of the station method, the one-lick method, and other methods and variations, yet every officer of experience will recognize in each the fundamental theories he has seen used repeatedly on fires. Here again, there has been more of doing and less of telling by the men who have developed the techniques. Methods have not as a rule been clearly defined, because fire chiefs have not fought a fire by the use of any one method, but rather by a variation and combination of methods. For example, Jim Girard taught me the use of the station method "way back when." He did not call it by name, and he originally used it primarily on mop-up work. Before that, I had been introduced to what I may call a "squad method," although I have never heard it named, and a head fire guard taught me an early variation of the one-lick method several years ago. A forest supervisor expounded the theory of "cold trailing." But I got all of this on the fire line, never anywhere else, and it's only in retrospect that I see it as instruction or training.

Since most reasoning is from the concrete to the abstract, isn't it logical that our techniques develop from fighting fires—and not that fire fighting develops after techniques have been set up? Perhaps the previous thirty-odd years form an essential "cut and try" period. Be that as it may, the training officer's problem now is to isolate these techniques, instruct in them, and then train in the common-sense application of them in various combinations for efficient fire-fighting work. The end sought is the trainee's ability to combine and apply his knowledge of fire-behavior and fire-suppression technique effectively.

Technical Judgment

Developing the judgment of an officer is difficult when dealing with concrete or physical things which must be appraised in order to arrive at correct conclusions or decisions. It is infinitely more difficult to develop judgment which deals with intangibles and potentialities and requires vision bordering on the prophetic. It can never be done with certainty where careful analysis and positive direction of the trainee's thinking and reaction is lacking. In short, the training of officers for overhead positions on fires requires the same long-time planned training and experience that is required to develop judgment in other important positions.

Is it not true that most firemen think in terms of their experience rather than in terms of fire behavior and methods? Start a discussion of fire behavior in a group of them and see how hard it is to keep the discussion going and how little they think in terms of fire behavior. Try the same thing in a discussion of fire methods and note the dearth of ideas. Watch the dog fight, however, when you toss an actual fire problem into the group. You will find varying points of fire behavior and of fire-suppression technique forming an ever-changing basis for discussion. Is this not a natural sequence of the way in which they have acquired their knowledge?

How often are the reasons back of fire strategy and important decisions on going fires explained to subordinate officers, who, in many instances, are admittedly in training? Have the key officers the time to do it while they are under pressure to get the fire? When should it be done? Where should it be done? How far should they go? Should they have the help of a training specialist? If so, what should their relations to each other be?

Get any group of fire-control devotees together and get them started on the problem of training fire fighters and the invariable conclusion is: "The way to learn to fight fire is to fight it. Every fire is different, you learn something from every one of them." For many years men have been sent to large fires for training. At least the value of the detail from a training standpoint has been considered. Is the training being done on such details effective? Is it enough? Should there be more training details to going fires? If the way to learn to fight fire is to "go fight it," shouldn't every major fire be made a training ground for junior or inexperienced officers? Here by common agreement seems to be the ideal place to train officers in fire-suppression work. Yet the results of this method so far have not been free from some disastrous failures. Some means should be found to make the training of men on "fire detail" more positive, and some means devised to appraise the effectiveness of the training so that on subsequent fires reliance may not be placed on officers whose training did not "take."

Human psychology is such that we seldom see the self evident, let alone the supporting facts or reasons for things that happen, unless we are trained to do so. We are largely creatures of fixed habits—in thinking as well as in doing, and our thinking is not always coordinated with our doing. That is why the expression, "Don't do as I do, but do as I say," is so frequently heard. In our fire-suppression work, for example, there is a wide spread between what is known about fire behavior and the essentials of efficient line construction and the corralling of fires, and putting such knowledge into practice. Much of the difficulty lies in the thinking and habits of fire fighters trained in the school of experience who continue to do things as they first saw them done or learned to do them on the line, rather than to question, experiment, or adapt methods to the needs of each particular fire. Every fire fighter will assert that every fire is different, and yet isn't it true that fundamentally fires are fought the same in New England, on the Pacific coast, in the South, and throughout the Lake States? The technique boiled down is to get a gang of men, give them a line, shovels, hoes or rakes, and a few axes and set them to throwing dirt or digging trenches.

Foremanship

The officer who is to direct fire-suppression crews must first of all be a good foreman, a leader, and handler of men. Knowledge of, or ability in fire-suppression technique will not compensate for lack of leadership. In fact, a good foreman who knows nothing of fire fighting except generalities will get more done on the fire line than will a technical expert on fire who cannot handle a crew. On a fire line, however, is no place to train men in foremanship. An axiom on a fire is that "if a subordinate can't handle the crew, replace him at once."

The Service may be accused of not training its men in foremanship in the past. Now, however, forest officers can take advantage of the training programs in the C. C. C. and E. R. A.

Does foremanship on the fire line involve anything different from foremanship anywhere else? Is foremanship important enough to receive special consideration in training for suppression work?

Knowledge of Organization

The basic essentials of good organization of fire-suppression forces are pretty well known, and it is not difficult to impart this knowledge to new officers. The trouble comes in getting the trainee to understand and appreciate how the members of such an organization should function. As a part of the presuppression effort splendid work has been done in instructing field officers in planning and organizing fire-suppression forces. Check lists of duties have been made for the various jobs in an organization. Perhaps the inexperienced officer needs to know what to do with his organization after he gets it; how to make it function effectively in the suppression of fires. He needs to be trained in analyzing his organization and in trouble shooting when it is in action so as to be able to correct weak spots before major breaks occur.

Organizing Ability

The trainee must have certain innate qualifications or aptitudes before he can be trained to organize, direct, and correlate the work of fire crews. This is largely a matter of executive ability which may be developed by administrative work not connected with fire. The problem in this case is one of training an otherwise competent officer in the application of the principles of leadership to fire-suppression work. If the trainee lacks executive ability, the start must be made from scratch, and a long period of apprenticeship training in administrative principles and their application is involved. In either case, the most difficult part is the development of the trainee's judgment, because this makes up a large part of the skill of an officer in any form of executive work. The trainee must have not only an adequate basis of fact or knowledge, but also must be experienced (practiced) in the correct use and application of that knowledge until he is efficient in organizing, directing, and correlating the work of fire crews.

Mobilization and Demobilization

Mobilizing and demobilizing fire organizations can be considered as a mechanical process for the service of supply. When, where, and how, is largely a matter of administrative decision for the fire chief. Both phases require administrative skill and judgment, and what has been said before would apply equally here.

Recognizing Potentialities

Someone has said that, "If our foresight were as good as our hindsight, we'd all be better off by a damn sight." An nowhere is this truer than on bad fires. The highest type of skill is required to foresee serious situations before they arise and to plan the attack so as to meet the trouble adequately when it comes. Ability to do this can be developed only where the trainee has been given all the basic training and experience essential to the job and is then trained in the critical use of that skill as a fire strategist.

Development of the capacity to recognize and appraise potentialities and ability to marshal fire suppression resources so as to meet such exigencies as occur is the final step in building officers for command of suppression forces. It can be accomplished only by a careful build-up of the officers concerned over a long period of training in which experience on fires intelligently analyzed and applied forms the primary factor of instruction. Matters of regional policy and the opinions and judgments of inspecting officers all affect the training problem. There must be a uniform understanding or interpretation of regional policy; men must be taught not to go to extremes. Inspecting officers must get all the facts and must distinguish between their opinions and their judgments. Whenever comment or criticism by inspectors is not fully explained by facts, the trainee will be further confused and judgments which may have been building up for some time are likely to be vitiated. The inspecting officer at this stage of the development of officers must consciously and conscientiously place himself in the position of an instructor. To do this he may use the facts gained from inspection, but he must use them with the attitude and approach of a trainer, not an inspector.

Confidence in Action

Most officers are more or less nervous and even panicky when they have to handle their first fire "on their own," regardless of its size. The less experienced the officer, the greater the likelihood that this feeling may seriously interfere with his effectiveness in directing the fire-suppression work. Occasionally officers of considerable experience will "go to pieces" on a fire. Many times it is only temporary; the officer soon "gets his feet on the ground." Training, habit, and discipline assert themselves, and he is able to function effectively in spite of himself. Besides inexperience, the physical condition of the officer, a combination of adverse breaks, not having had a bad fire for a number of years, or any one of a number of causes, including incompetency, may cause him to "blow up." Perhaps there is no

panacea, no training which will prevent the occasional break from lack of or loss of confidence and the surrender of an officer in command to excitement, pressure, or fear. Training and experience on fires will minimize the chance of going to pieces, but the human element must be considered with all the charity possible when such trouble does occur, even though appropriate action must be taken after all circumstances and results are determined.

Summary

Summarizing the problem of training overhead for fire-suppression work we find that:

1. There is need for training in certain basic knowledge of fire-suppression work as a foundation.
2. It is necessary to train in the application of that knowledge.
3. The major problem is one of developing confident leadership, supported by well developed administrative ability and sound judgment in the executive and technical work of fire suppression.
4. There are certain limitations beyond which training and experience cannot go.
5. No new training methods are involved.

Perhaps the most vital factor is not only the recognition of the need for training, but also the acceptance of the responsibility for training by those in charge of fire-suppression work. Much of the training necessary can be given only by those "in command." Possibly we need to go back of our overhead failures on fires and check up on the officers under whom the personnel were trained for deficiencies in executive ability and skill in training.

A great spread exists between what is known and what is practiced in corraling, controlling, and mopping up of fires. Part of this is the result of following established habits of work; part is the result of the failure to think. Training to date has been largely concentrated on the "doing" end of suppression work. The training of overhead involves primarily instruction in analytical and critical thinking in fire suppression. This is a harder, slower task, because it calls for the conscious guidance of the mental reactions of the trainees. Greater progress will be made when thinking is more closely coordinated with doing in corraling and controlling fires.

APPLICATION OF PANORAMIC PHOTOGRAPHS IN LOCATING FOREST FIRES

BERNARD H. PAUL

Assistant in Charge of Intelligence Division, Los Angeles County Department of Forester and Fire Warden

The fire detection system of Los Angeles County, Calif., consists of 26 lookout stations, 10 of which are operated by the County Department of Forester and Fire Warden, 14 by the United States Forest Service, and 2 under cooperative arrangement. Each of these obser-



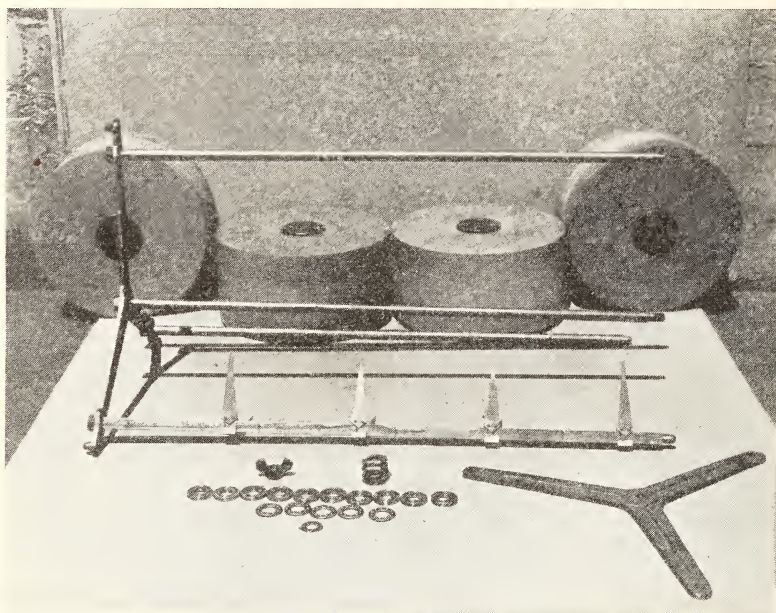
Rotating panoramic photographs being used by dispatcher.

vation units is equipped with an Osborne fire finder, providing both vertical and horizontal angle readings.

Since the ordinary dispatcher's map recognizes application only of the horizontal arc, in order to take full advantage of these instruments it was necessary to devise another method of interpretation. This consists of a rack, or stand, containing panoramic pictures taken from four different towers whose coverages are composite. These photographs, upon each of which is superimposed azimuth circles reading to 30 minutes or arc, are mounted on the periphery of separate drums whose perimeters equal the overall length of the prints. The drums are placed upon a vertical spindle and revolve on ball bearings on a horizontal plane.

One of the three side braces is equipped with four adjustable pointers, one for each drum. Vertical movement of the pointer is directed by a scale giving plus or minus angles from the horizontal.

The operation of the instrument is simple. With the azimuth and vertical angle given by the observer, the dispatcher rotates the drum until the pointer is coincidental with the readings. Familiarity with the terrain is vitally necessary, particularly on those instances where indirect observations occur. Cross-readings, or intersections, are



Component parts of the rotary rack.

obtained visually from an inspection of the position indicated by the pointer on different drums.

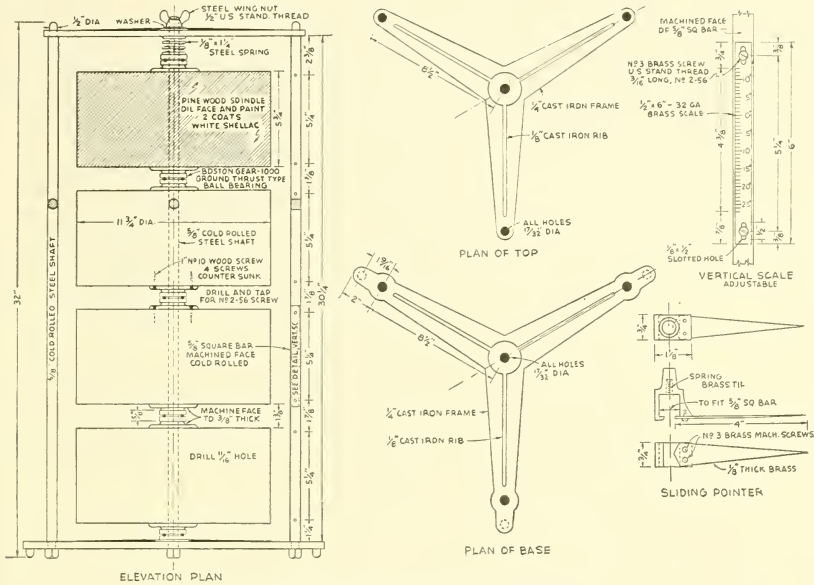
The whole assembly takes up little room and can be placed on the desk within convenient reach of the dispatcher, which obviates the necessity of leaving the phone unattended as in the use of the standard wall map. It also permits operation during conversation with the observer.

The value of this device as a public relation factor is important. The "topog" map, azimuth circles, and strings are somewhat difficult for the layman to comprehend, but he readily understands a photograph, particularly when it depicts country familiar to him. People are attracted by anything that moves, and once the drum is revolved before the inquirer's eyes he is interested and his attention is obtained. Pertinent questions aroused through this medium provide an excellent opportunity for the fire warden to spread the gospel of fire prevention.

The instrument itself consists of two castings, the bottom support and the cap, a central spindle, and three braces. Two of the vertical side rods are cold-rolled steel, and the third is a square bar upon which are fastened the scales and the adjustable pointers. The drums are of seasoned sugar pine with ordinary pipe flanges for hubs and are separated by annular ball races. The pointers are held in place by a

friction device consisting of a small coil spring and a ball bearing. A larger coil spring placed between the topmost drum and the bracket exerts sufficient pressure to regulate the turning movement of the drums, as well as to compensate for lateral movement on the spindle. The whole assembly weighs approximately 40 pounds. It can be dismounted quickly and alternate drums may be set in place within a few moments.

A local engineering concern has built a dozen of these rotary fire finders on this department's specifications at a cost of about \$30 per unit.



Plan of rotary fire finder using panoramic photographs.

AN IMPROVISED FIRE-HOSE BRUSH

J. E. RITTER

Region 7, U. S. Forest Service

Every fire fighter who has use for and access to power pumps is confronted with a current maintenance job, as well as the annual problem of storage of fire hose.

Even a double-cotton-jacketed, rubber-lined hose or a linen hose of substantial weave is subject to wear if much abrasive material is encountered in the field. Cleaning the hose in preparation for the next fire or for winter storage also subjects it to wear. Some recommend that brushing linen hose in any manner be avoided. Others suggest light brushing to get off the dry mud and dirt.

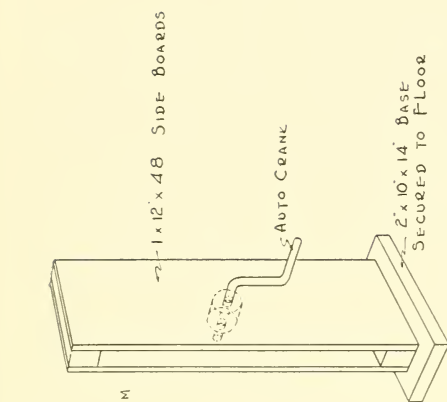
When traveling in New York State last summer I observed a brushing device built by a fire-control man. It was simple, inexpensive, but effective. A homemade hose reel was constructed from a couple of breast-high uprights of 1 by 12-inch material fastened to a base standing on end, spaced a little wider apart than the width of dry hose (1½ inches diameter), through which was inserted an old automobile crank with core to hold a bite of hose preparatory to reeling up the section.

Fastened to a box or stand approximately 2 feet in front of the reel were the heads of two fiber brooms (approximately 4 by 16 inches, with 4-inch fibers), one inverted over the other. The lower one was fastened securely to the stand while the other was hinged so that it might be opened for inserting hose and then closed or tightened with the hand or foot to obtain the desired pressure.

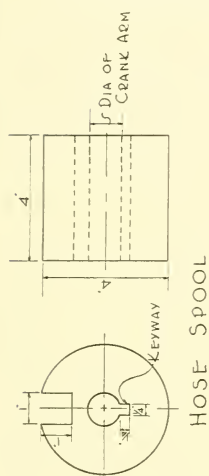
The hose is placed between the fibers of the two brooms in a horizontal position, inserted in the reel and coiled into compact rolls of convenient diameter by merely turning the crank, applying pressure on the brush sufficient to knock off the dirt. If the hose and mud are extremely dry, the mere weight of the brush will be sufficient to take off the dirt with little if any danger of injuring hose threads.

The type of brush used in the hose cleaner was adopted, I understand, merely to utilize materials on hand and to avoid further investment. Many other types of fiber or bristle brushes should be just as effective.

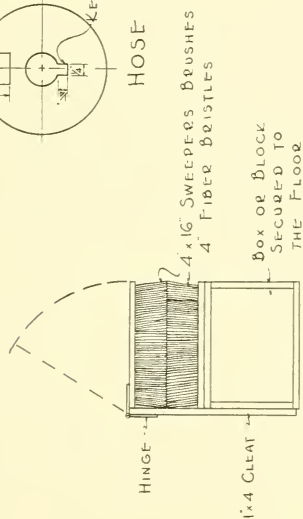
The reel described is most suited for 50-foot lengths of unlined linen hose. The accompanying sketch of the device may be of assistance to others in developing and constructing types of cleaners adaptable to other sizes of hose.



HOSE REEL



HOSE SPOOL



HOSE BRUSH

AN IMPROVED FIRE HOSE BRUSH & REEL

This simple fire-hose brush is inexpensive, but effective.

PORTABLE HOSE REEL

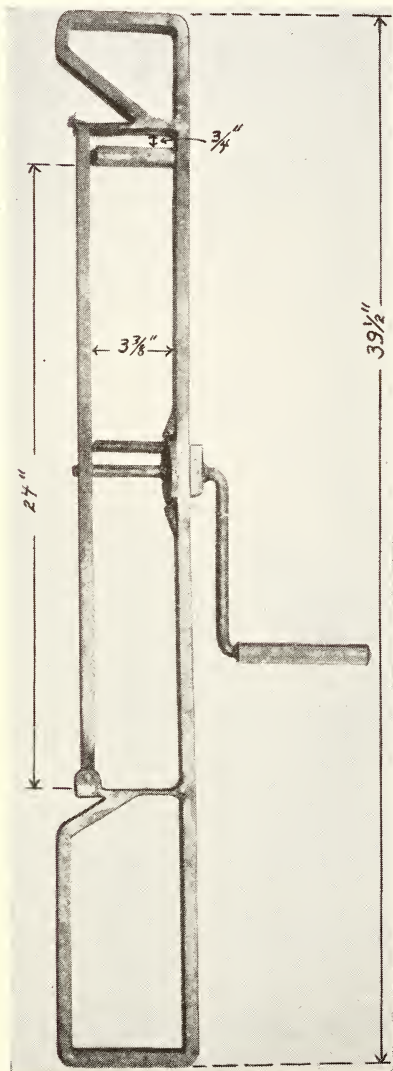
A. P. SWAYNE

Superior National Forest, Region 9, U. S. Forest Service

Historically, the need for a portable reel to handle marine pump hose was first felt at the Rocky Lake fire on the LaCroix Ranger District of the Superior National Forest during the 1937 fire season. With 5,000 feet of hose to be moved several times, the problem of rolling and laying it out became acute. The remoteness and roughness of the area brought out the necessity for lightness and portability in any reel developed.

The essential features of the reel illustrated are easily understood. A staff, with a hand grip at the top and a stirrup at the bottom, makes up the entire frame. A bearing is set near the middle of the staff with an axle slightly longer than the thickness of the staff. The axle is turned by a crank with a folding handle. On the other end of the axle is the fork. This consists of two tines, of which one is the prolongation of the axle and the other is offset from it about 2 inches and parallel with the first. Their length is equal to the width of the hose when flat. A hinged hose guide that latches in position beyond the fork is the only other part.

In rolling up a length of hose the reel is first set at about the middle of the hose and the hose guide opened. The hose is then laid between the tines, the guide is closed, and by turning the crank the hose is reeled into a compact roll. A groove in the offset tine facilitates tying the roll, and the guide is then opened and the hose may be lifted from the tines ready to be transported. The hose, rolled from the middle, reels in much more rapidly than when rolled from one end. The couplings are on the outside of the roll and may be screwed together a couple of turns to prevent battering of the threads. The rubber gaskets can be left in place without chance of getting lost when this is done. The action of the reel gives



Weighing only 7 pounds, this portable reel is so shaped that it will pack readily with any pump-equipment outfit.

hose with water in it a chance to drain from both ends, making it unnecessary to drain hose before rolling for short quick moves, and thereby saving much time.

The weight of the reel is 7 pounds when made of seamless tubing. Its shape lends itself readily to packing with any pump equipment outfit. The illustration shows a model made of channel iron, but the weight of this material makes its use undesirable. The material recommended, and which is being used, is $\frac{3}{4}$ -inch diameter, 18-gage, cold-drawn, seamless tubing.

Use of this reel, by furnishing a quick and easy method of moving hose, should cut down the tendency to drag hose for short moves under the stress of fire conditions. Increase in the life of the hose should be the result.

Past experience in rolling hose by hand and tests with the reel indicate that under fire conditions it will likely be fairly easy to cut the time of picking up hose by 40 percent and stringing it out by 20 percent. Inexperienced C. C. C. enrollees were used for these tests. The tests with dry hose were made on level, cleared ground. The test using wet hose was made on rough ground, following a crooked trail through timber, under conditions similar to a fire trail. The results of the tests follow:

TEST 1. DRY HOSE

	<i>Seconds required to roll by hand</i>	<i>Seconds required to roll by reel</i>
100 feet linen hose-----	{ 90 80 85	{ 5 10 5
Average-----	85	7
50 feet rubber-lined hose-----	{ 65 65 65	{ 5 5 5
Average-----	65	5

TEST 2. WET HOSE (PARTIALLY FULL OF WATER)

(a) Time required for one man to uncouple, roll by hand, tie, and sack 3 lengths described above was 10 minutes and 30 seconds.

(b) Time required for one man to uncouple, roll from the end with the reel, tie, and sack the same hose as (a), about 6 minutes and 30 seconds.

ELAPSED TIME CALCULATOR

Region 1, U. S. Forest Service

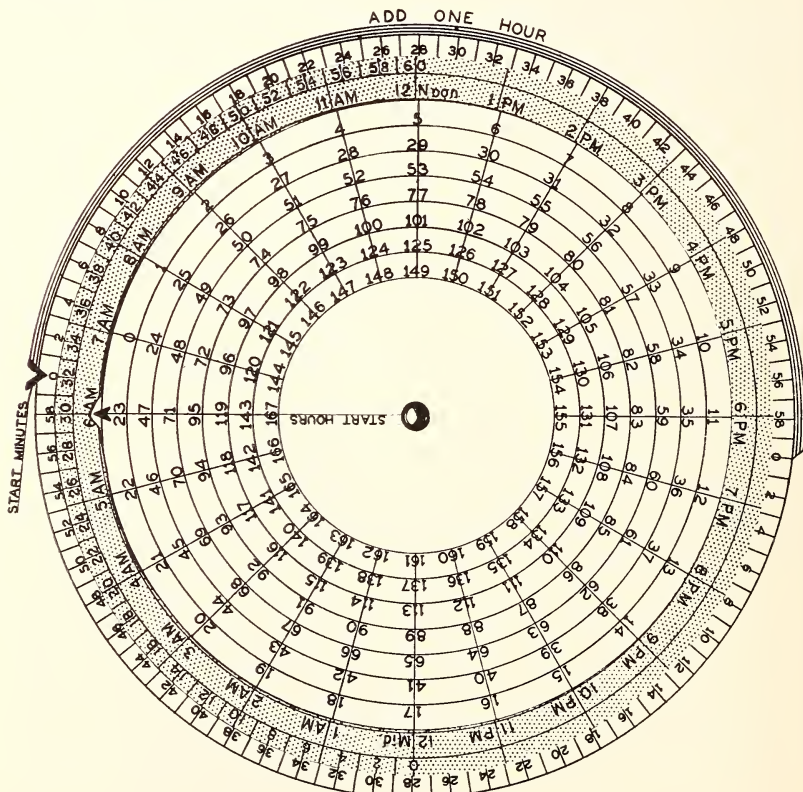
Region 1 saves time and improves accuracy by the use of the 8-by-11½-inch card illustrated. The small and medium dials are attached to the card by a simple brass eyelet. The large dial is printed on the card itself.

The instructions on the card are as follows:

Figures on small circle indicate elapsed time in hours, each succeeding line toward center represents a 24-hour period. Figures on largest circle indicate elapsed time in minutes, upper half represents 1 hour and minutes as indicated.

Figures on middle circle indicate the time of day in hours and minutes.

Example.—To calculate elapsed time from 6:32 a. m. July 21 to 4:18 p. m. July 25: Set pointer on small circle at 6 a. m., move both small circle and middle circle until pointer on larger circle is at 32. Then read hours on small circle down 5 places at 4 p. m. we find 105 hours; then read large circle where the figure 18 is located on the middle circle and we find 46, which gives us 105 hours and 46 minutes, total elapsed time.



To determine the number of places to count off on the small circle (from outer row towards the center), determine the exact number of full 24-hour periods between the two time figures and dates used, allowing one place for each full 24-hour period, beginning with the second place of the figure row. If the minute reading on the last date falls in the upper half of the large circle, add 1 hour to the reading in hours shown on the small circle. If the minute reading falls in the lower half of the large circle, use the reading shown on the small circle for the time indicated.

A FIRE-CONTROL TRAINING MAP

H. B. ROWLAND

Project Forester, Farm Security Administration

Often in connection with fire-control training, it is difficult to put over properly certain phases of the work by explanation, diagram, or other usual methods of presentation. One difficulty is to present a bird's-eye view of the entire fire and the whole process of suppressing it. It would help if we could picture vividly the necessity of concerted and coordinated effort, and the relation of each man's job to every other job and the part they all have in successful accomplishment. Another problem is to visualize the importance of time and quick, accurate judgment. Fake fires and small burnings are of some help, but they have their limitations. Several years ago, the writer, having these problems in mind, developed an animated relief map on which experimental fires could be burned.

At first, a small indoor model 3 feet square was made of asbestos plaster, with a scale of 1 foot to the mile. Since then, a large 10 by 15 foot outdoor model has been built of concrete. The relief maps were taken from a standard topographic sheet. All the usual characteristics are represented, roads, trails, streams, towns, towers, and warden locations. A large visible scale helps as a yardstick.

In use, the map is dusted over with a green inflammable powder made to burn at a given rate of speed. The powder represents the inflammable forest fuel and burns with a slow, creeping, sputtering action without flame.

The powder is a mixture of wood flour and saltpeter, with a dash of chrome green pigment for color. About 23 parts by volume of wood flour and 1 part pulverized saltpeter, thoroughly shaken together, should make the proper mixture, although a little experimenting must be done. A few less parts of wood flour make a "flash" powder and a few more parts make a fuel that is too slow or that will not burn at all. Several types of fuel make variable conditions on the same set-up. All unburned powder can be brushed up for future use.

On a large map several problems may be worked out with one dusting, or the map may be brushed off and repowdered each time. The powder is used about $\frac{1}{8}$ inch deep, but variation in amount offers different conditions. The rate of burning is regulated by the mixture used. The speed of burning over the map gives a time scale for all action. In use the passage of time is marked by a timekeeper or large clock face. On the scale suggested, 1 minute represents 1 hour of time.

A small stylus was devised to rake the powder aside as in a raked fire line. The stylus was figured to scale on the basis of a 10-man crew. On the map-scale mentioned, an ordinary pin with the head clipped off set in a small stock or pencil answered the purpose. With such a gadget one can rake line on the map at a rate representing the work of 10 men raking line through ordinary hardwood conditions. One soon becomes tired trying to beat the line scale too much and unless the line is raked correctly and safely the fire usually creeps over.

So far the experiment has been based on the average powder burning normally. A little adjustment of the powder makes fast or slow burn-

ing fuel or fuel that will not burn at all. Well dried fuel will burn faster than that at ordinary room conditions. A small electric fan speeds up the fire and a gusty wind may even cause small spot fires to jump ahead, as a mere spark ignites the powder. With all these combinations of wind and fuel, it is possible to simulate almost any fire condition even to a complete "blow-up." Special care must be taken to see that the various scales are correctly worked out.

With a judge, timekeepers, and observers appointed and the conditions explained, other men are selected for fire boss, wardens, tower-men, runners, helpers, etc., each man handling his own part. Helpers are sometimes needed to carry out the work of some officer, since the time element is speeded up. A small mimeographed map of the set-up may be of assistance.

A spark or match starts the fire. It spreads in all directions. The fire is discovered and reported, in the proper or designated elapsed time, by the towerman using a small map and alidade. Wardens are called and travel to the fire by elapsed time of distance and time scale. Upon arrival the warden sets to work to surround the fire with a safe line. His stylus keeps him in scale. When the fire reaches his line, it goes out for lack of fuel if the line is safe, or he may backfire with a helper. If the line is not safe, the fire usually creeps over. The break-over is handled only in scale for discovery and travel back and at the expense of the forward line. According to the burning conditions created, the fire may be a simple one-man fire of a few minutes or a many-crew fire of longer duration.

Any changes, additional crews, and the handling by the fire boss must be done according to time schedule for scouting, messages, travel, etc. This often shows quite obviously the exasperating things that happen on a fire because of the changes continually brought about through time. Often it is easy to see on the map immediately what should or could be done to take care of a certain situation then plainly visible—only to see the chance lost as the time element has its play. The map also gives a bird's-eye view of all parts and the simultaneous actions which are taking place on all sides to complete the whole. All work done is left recorded in the ash or dust after the fire is over, which makes possible a detailed review. One may in this way use the device as a problem table, or an instructor may use it alone to demonstrate methods and procedure in handling a fire.

Quite easily and naturally the results of good and poor judgment, delay, confusion, misunderstanding, haste, etc., may be seen. Action may be allowed to follow a natural course, or a situation may be deliberately worked up to a definite problem for individuals to tackle. With a little planning and manipulation actual fires may be reenacted in miniature. Innumerable modifications and adaptations are possible, but the fire actually burns and makes its own problems and must be put out if it is to be stopped.

In this day of intensive training for fire control in Federal and State service and C. C. C. camps, a training map such as that described might be of value to training officers and others. Such maps are quite easily made and inexpensive. They offer possibilities for real action, interest, and instruction, limited only by the imagination and resourcefulness of the directing officer in devising problems and details.

FUEL FEED SYSTEM FOR FIRE PUMPS

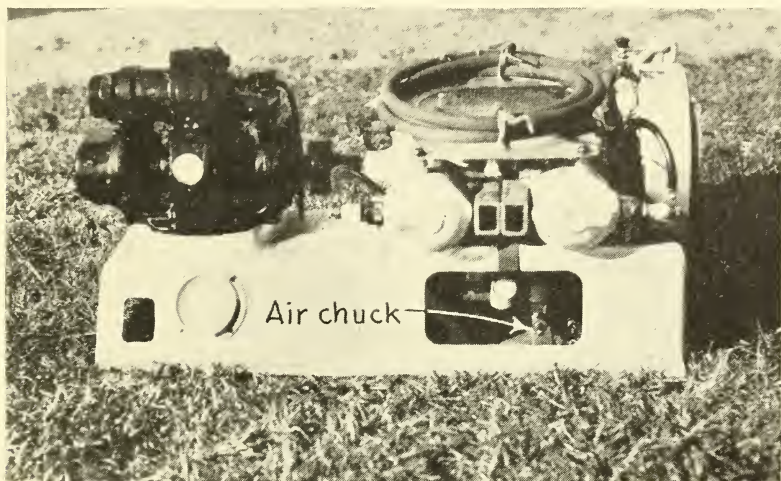
BENJAMIN A. WILEY

Mechanic, Superior National Forest, Region 9, U. S. Forest Service

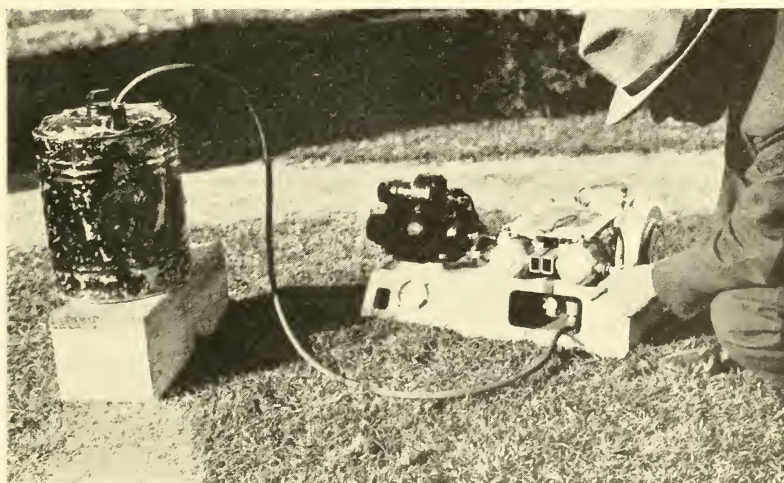
Comprised of: One $\frac{1}{4}$ -inch, red rubber-covered air hose 7 feet long, and one Schrader air-chuck coupling, $\frac{1}{4}$ -inch in size.

Total cost: Approximately \$1 for both hose and coupling.

How to construct: Remove present $\frac{1}{8}$ -inch feed line from settling basin and enlarge hole with $\frac{1}{4}$ -inch drill to take $\frac{1}{4}$ -inch copper pipe. Insert and solder in $\frac{1}{4}$ - by $1\frac{1}{2}$ -inch copper pipe. Insert other end of pipe



Fuel-feed unit unassembled for transportation or storage. Note position of air chuck.



Fuel-feed unit assembled for operation showing flexible-rubber air-pump hose attached to air chuck on carburetor feed line.

into the air-chuck coupling and solder in securely. Run $\frac{1}{8}$ -inch drill through coupling to enlarge passage and to remove any solder which may have entered pipe.

Time required to construct: 10 to 15 minutes.

Designed to eliminate: (1) Clogged fuel feed pipes caused by dried sediment and scale which collects in fuel tanks during periods of nonuse; (2) the soft, easily crushed and leaky gas tank with its attendant fire hazard to the pumper itself; (3) the necessity of stopping the pump every 45 minutes for refueling, thereby saving 1 hour of each fire-fighting day lost in refueling the small tank—this usually hurried

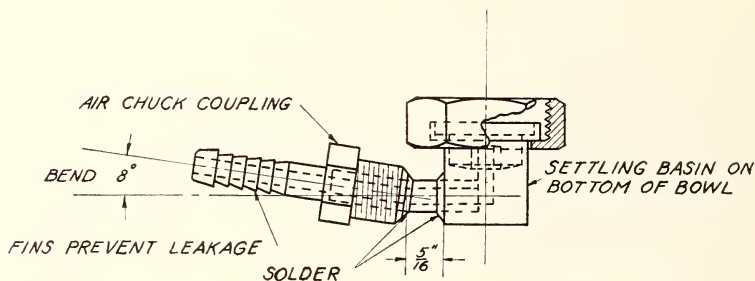


Diagram showing details of fuel-feed system.

refueling often results in overfilled tanks, with more fire hazard, oil-soaked spark-plug wires and magneto parts; (4) the necessity of carrying a funnel.

Provides: (1) An uninterrupted safe fuel supply; (2) a fuel system that can be completely cleaned in 3 minutes.

Tested: (1) By many hours in actual service; (2) hose tested by soaking in gasoline for 200 hours.

Reaction: Hose swells, but not sufficiently to interfere with fuel supply. After removing from gasoline it returns to its original size in a short time.

METHOD FOR MEASURING PERIMETER OF FIRE

GEORGE M. BYRAM

Appalachian Forest Experiment Station

In FIRE CONTROL NOTES for December 6, 1937, J. A. Mitchell described a rule of thumb for computing the rate of spread of a fire in terms of the rate of perimeter increase. According to his rule, the rate of perimeter increase of a fire is equal to approximately 3 times the rate at which the head of a fire is advancing. As Mitchell points out, if a fire spreads at equal rates in all directions, the rate of perimeter increase is 2π or 6.28 times the radial rate of spread, but since fires burning in a wind tend to spread primarily in one direction, the ratio is more nearly equal to π , or approximately 3.

A similar method can be used to estimate accurately the perimeter of a fire regardless of its shape. If the boundary of an irregular area A ,

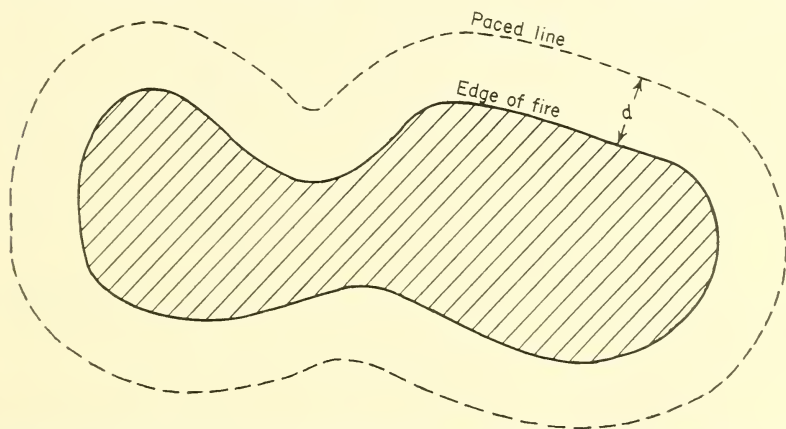


Diagram illustrating method of measuring fire perimeter. The perimeter equals the length of the paced line minus $2\pi d$.

such as that illustrated, is paced so that the pacer always keeps at a constant distance d from the boundary of area A , the perimeter of A will be equal to the distance traveled by the pacer minus $2\pi d$, or approximately $6d$. For instance, if the pacer always traveled at a distance of 30 feet from a burning fire, he would subtract 6 by 30 or 180 feet from the total distance traveled to obtain the correct fire perimeter.

It might appear that this rule would hold only for circular areas, but it can be shown mathematically that it applies to any area regardless of shape. A practical difficulty would be encountered on fires where narrow necks or intrusions had widths less than $2d$. In such cases, if the pacer kept at a distance d from the burning edge, he would be obliged to walk partly within the adjacent burning area. However, this condition probably is seldom encountered in actual practice.

If the fire spreads at an appreciable rate while the pacer is measuring its perimeter, he will not be able to close the curve when he reaches the starting point. However, if he stops opposite the starting point on a line perpendicular to the fire's edge, he will obtain an approximately correct perimeter.

METHODS OF USING DRIVEN WELL POINTS FOR FIRE-SUPPRESSION PURPOSES

L. J. ASHBAUGH

Assistant Forester, Upper Michigan National Forest

The use of driven well points to obtain water is known to many men who are concerned with the suppression of forest fires. Their use is quite limited, however, depending upon the nature of soils and the depth to water-bearing levels. Where a large percentage of the area in which fires occur is in swampland or sandy, rock-free highlands, having relatively high water tables, well points can be used to very good advantage. They can be driven to depths of 30 or 40 feet under optimum conditions. Ordinarily 10 to 20 feet is more within the driving range in swampy areas because of the high water table.

The methods described here have been used on the Upper Michigan with good success.

The Well-Point Driver

A well-point driver is necessary in order to quickly and efficiently drive pipe to required depths. Two men can drive pipe without loss of time with the driver shown in figure 1 in the illustration.

In using the driver the following points should be noted:

1. Always cap the driven pipe to avoid punching a hole in the babbitt, to give larger striking surface, and to avoid injury to threads of pipe being driven.
2. Pipe lengths should not be cut longer than 6 feet.
3. Pipe joints should be leaded to eliminate suction. In the field a bar of brown laundry soap used on the joints is sufficient.

The well-point driver is of relatively simple construction. The cap should be acetylene welded to avoid its being punched out by the force concentrated on it during driving. Holes are drilled through the pipe at the points indicated in the drawing to take the $\frac{3}{4}$ -inch tool-steel handle. The handle should have a snug fit. The babbitt will hold it in place.

Use of Single Well Points

Well points should be $3\frac{1}{2}$ or 4 feet long; 60-mesh screen is usually considered best for all purposes; $1\frac{1}{4}$ -inch points are in general use.

Single points may be driven and a standard well or a pitcher pump attached. The pitcher pump is most desirable where the water table is high, because of ease in handling and attaching it. This type of driven well is of most value for filling water and pump cans where water is not available nearby or must be hauled long distances.

Use of Multiple Well Points

Two or more points can be driven for use with a power-pump unit and will supply a steady flow of water for use in mopping up hot lines.

In order to draw from as large an area as possible the points should be located 8 or 10 feet apart. This will take better advantage of

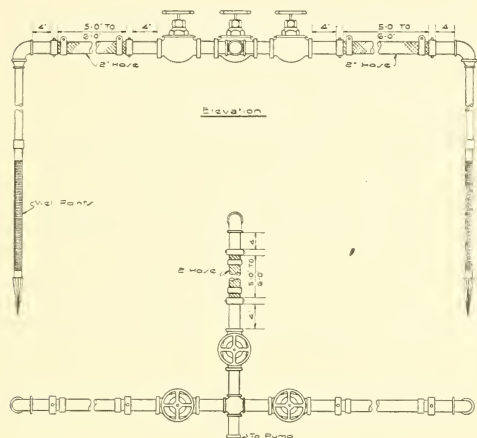
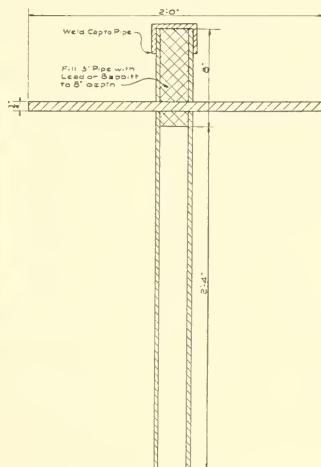


FIGURE NO. 2
Multiple Well Point Connection for
Fairbanks Morse or similar type Pump



Well Point Driver
Size 2.0" x 1.0"

FIGURE NO. 1

BILL OF MATERIALS

FOR FIGURE NO. 2

- 2 2" Galv Iron Fitter Elbow
- 1 2" Galv Iron Pipe Appr
- 1 2" Galv Iron Pipe Cross Fitting
- 1 2" Galv Iron Pipe Reducer
- 1 Gate Valve
- 1 2" Hose Clamp
- 1 2" Well Coupling with Hose End (Female)
- 1 2" Hose End (Male)

FOR FIGURE NO. 1

- 1 2" 3 x 3.0 Galv Iron Pipe
- 1 2" Pipe Cap
- 1 2 x 2.0 Galv Iron Red
- 2 2" Lead or Babbit

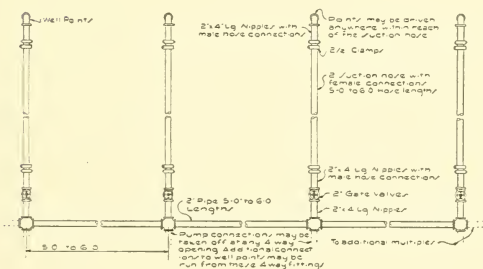


FIGURE NO. 3
How method of connecting multiple
well points in series

water bearing levels, and also avoid bunching equipment and men at work. While a second point is being driven the first may be rigged and attached to the pumper.

Where flexible intake suction hose is used, it is not necessary to drive the well points in line. Also, it is not necessary that the pipes extend equal distances above the ground. The only requirement is that the distance between the points be within the limit to which the couplings and suction hose are cut and can be extended.

In driving individual points, a cone-shaped hole should be dug at the point of driving. Water can then be poured alongside the driven point to eliminate sucking of air when the pump is put in operation.

When a multiple unit is set up, all joints should be leaded. A bar of brown laundry soap will serve the same purpose in the field.

Use of a four-way coupling with nipples makes it possible to hook directly as shown in figure 2 of the illustration, the fourth connection being the pump intake. If gate valves are also used it is possible to cut out any or all well points. One point may then be put in use while another is being sunk, or a point which is sucking air may be cut out.

If T's are substituted for elbows directly on the take-off from any one individual point, an additional extension can be made to another point 8 or 10 feet distant.

From the point of take-off at the well point, 2-inch piping, couplings, and valves are used.

The four-way connection with valves attached may be set up with leaded joints as may also the 2-inch suction hose units with female swivel couplings attached. Elbows or T's with nipples attached may similarly be prepared in advance.

Upon driving the point it is merely necessary to attach the elbow with nipple and reducer attached. The suction hose with swivel couplings is then attached to the nipple, the other coupling being ready to attach to a four-way valve unit. As other points are sunk, they are in turn coupled to the four-way valve unit. The pump, also attached to the four-way valve unit, may be placed in operation as soon as sufficient points have been connected to furnish an adequate water supply. Points may be cut in or out at will by use of the valves.

As will be noted from a study of figure 2 in the sketch, two points may be anywhere up to about 12 feet apart, while the third may be about 6 feet to the rear of the center point of the line connecting the first two. This gives an ideal spacing. If more points are sunk, they may be extended beyond the first points to distances governed by equipment available, topography, etc. The flexibility of the intake hose permits selection of well-point locations as governed by physical features of the ground, rocks, stumps, etc. While the suction hose lengths of 5 feet, as shown in the sketch, together with couplings, increases the total length to around 6 feet, it is permissible to have somewhat longer or shorter connections. The lengths may be increased by 2 or 3 feet, but should not be shortened to less than 4 feet because of the difficulty in bending short lengths of suction hose.

Figure 3 of the illustration shows a method of hooking up multiple well points, using a main-line pipe and four-way couplings. It will be noted from a study of this sketch that points may be driven on either side of the main line, the only governing factor being the length of the suction hose couplings. Points may be placed all on one side of the main-line pipe, on both sides, or at selected points on either side. Similar latitude is allowed in the selection of the pump location, which may be at either end of the main-line pipe or at any one of the four-way connections. It will naturally be placed so as to be nearest the largest group of working points.

Flexibility is one advantage of the unit, and allows points to be sunk at almost any location. The units are designed in multiples which may be changed, added, or removed at will or cut off by use of gate valves or plugs. Four-way connections with valves attached should be kept intact and assembled at all times if possible. The suction hose with swivel couplings is very convenient, inasmuch as it can be quickly attached with the use of only a spanner wrench. Rubber washers eliminate the need of soap or white lead when attaching hose to the pipe or nipples.

Power Pump and Engine

Fast motors, cooled by circulating water from the intake, are not adaptable to this type of hook-up because of their high speed. Any great variation of water flowing through their cooling systems would soon cause them to burn out. Pacific marine or Evinrude motors are, therefore, not adaptable to this form of use. Instead a slower motor, with self-contained water cooling system is used.

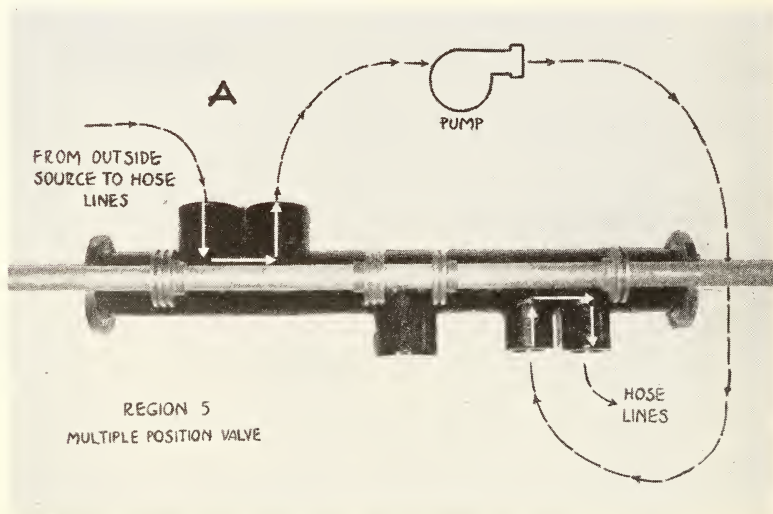
The Fairbanks-Morse type of pump with simple gasoline engine attached has been used very successfully. Other similar types of motors are doubtless available, although we have not had experience with them. The one used does not demand such a constant or heavy flow of water, and a temporary lag or halt in the water stream in no way harms the motor, which is cooled by its own water supply. The use of 2-inch intake suction hose for connectives between well points permits easy flexibility without buckling because of the vacuum created by the pump.

THE MULTIPLE-POSITION VALVE

F. W. FUNKE

Fire Equipment Specialist, Region 5, U. S. Forest Service

There has long been a definite need for a quicker and easier operating valve-control manifold for use on tank trucks, not so much because of the time element involved in operating a set of valves, but because of the value of simplicity in the use of such a device. The training of tank truck operators becomes much simpler when the various pumping system-control operations are reduced to a minimum, and the possi-



bility of failure in critical situations because of complicated valve systems is greatly lessened.

In order to introduce the necessary flexibility in a tank truck piping system, various control valves are required. Including the feature of drafting from either side of the tanker a minimum of five individually operated valves in units of this type are necessary for the delivery of water from an outside source to the hose lines, from an outside source to the tank, and from the tank to the hose lines.

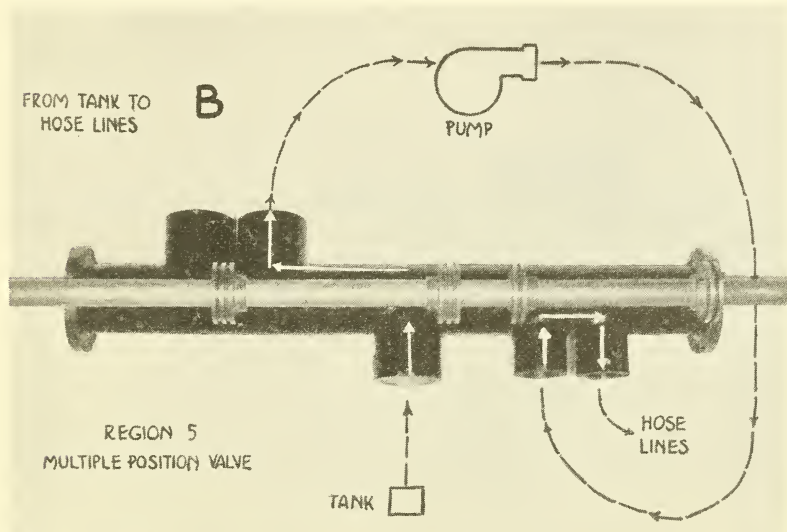
Although gate valves are acceptable on the suction side of the pump, plug type valves must be used on the pressure side. Quality and size of this equipment make the cost rather high. The plug valves must have ample waterway area and be of the high-pressure type with a rating of not less than 350 pounds hydraulic.

Some development has occurred in multipurpose manifolds during the past decade. The State of California Division of Forestry developed a built-up pipe section bypass manifold to reduce piping requirements on various types of tank trucks. The Cleveland National Forest in Region 5 developed a three-way valve adapted from the Merco-Nordstrom valve and used it on a number of their tank trucks with success. While investigating the Cleveland development,

looking toward its adoption as a regional standard tanker valve installation, certain remediable deficiencies became evident. The result of the investigation was the development of the multiple-position valve illustrated.

While the various valve and piping arrangements included in multi-purpose installations have served a very definite purpose, practically all have included in their design various features which restrict their usefulness in tank-truck systems. Constricted waterways and a multiplicity of L's and bends are usual.

When the fact that a $1\frac{1}{2}$ -inch, 90-degree elbow is equivalent in friction loss to 8 feet of $1\frac{1}{2}$ -inch pipe is considered, it is easy to see where a relatively high loss can be introduced in the system unless



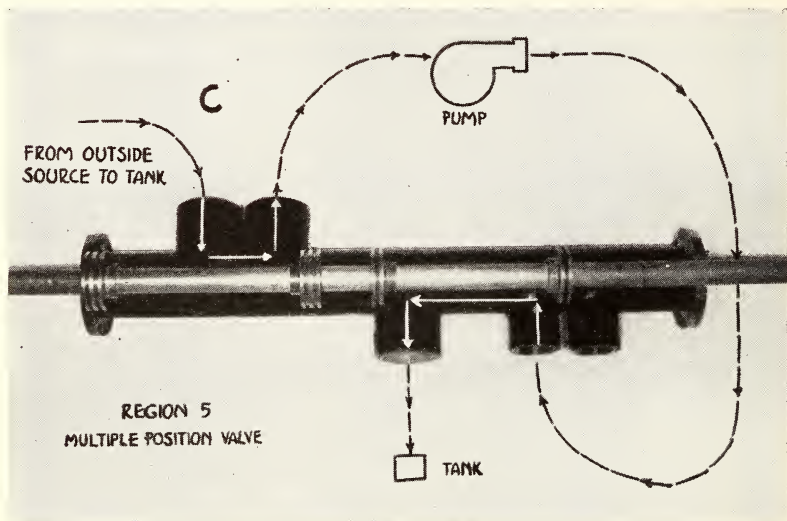
care is used in laying out the pipe lines. Using the theoretical friction-loss factor of 0.11 pound per square foot for $1\frac{1}{2}$ -inch smooth iron pipe, it can be assumed that each 90-degree elbow will create 0.88 pound per square inch friction loss. It is obvious that much of the power of the pump can be wasted in the piping system unless care is used to reduce L's and returns to a minimum.

The development illustrated consists of a cast-brass valve body and a conventional piston and rod arrangement. As illustrated the piston valve has been superimposed on the valve body to indicate the arrangement and type of valve. The valve body consists of a tube having a 3-inch diameter bore with three $2\frac{1}{2}$ -inch openings and two $1\frac{1}{2}$ -inch openings. The piston valve consists of a length of $1\frac{1}{4}$ -inch brass pipe, on which are suitably placed several pistons equipped with Monel-metal rings. The valve body contains webs over the various openings to hold the rings in place while passing over the orifices. Water seal and lubrication is provided through an alemite fitting attached to one end of the piston rod and outlet holes to the ring grooves. Flanges on the ends of the valve body proved a suitable

means of mounting the casting for machining and later mounting in the truck chassis.

A, B, and C in the illustration show the relative position of the piston valve for the various operations. These should be quite clear from the schematic outline.

The unit assembly is mounted crosswise in the chassis and is operated either by means of a lever and segment, which provides for three stops indicating the position of the piston, or a hand wheel and screw attached to the piston rod which actuates the valve rod. A suitable indicator plate shows the position of the valve (not shown).



The device requires a valve body 34 inches long; the size of any particular unit is dependent upon the relative size of the openings and waterways.

The ends of the valve body should be packed after mounting with a small plate and a dustproof felt to prevent road dust from entering the bearing surfaces.

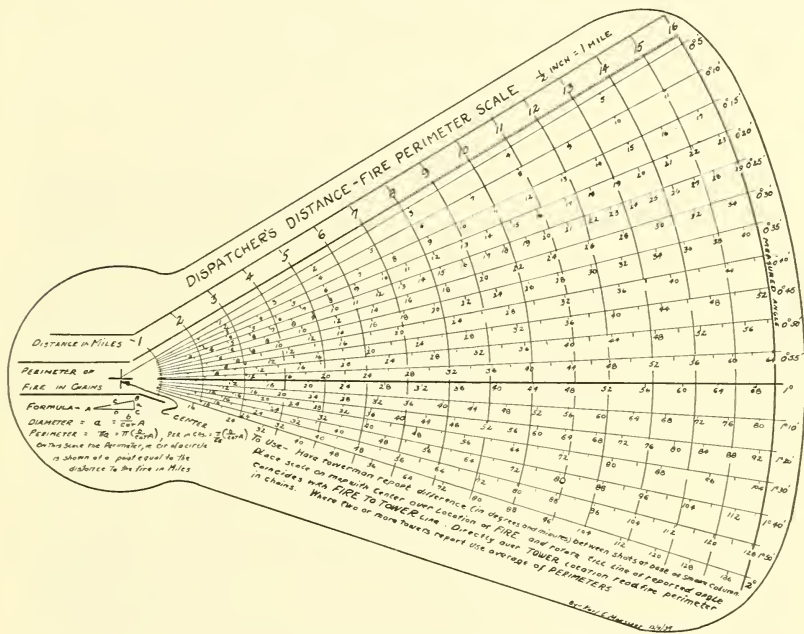
Shop detail blueprints of the device may be obtained by addressing the Regional Forester, United States Forest Service, Phelan Building, San Francisco, Calif. United States Forest Service agencies may make arrangement with the supply depot for purchase of the device. Such units will be furnished with unfinished piston rod ends, which can be cut to the individual installation.

A DISPATCHER'S DISTANCE-FIRE PERIMETER SCALE

KARL E. MOESSNER, *Junior Forester, Upper Michigan National Forest, Region 9, U. S. Forest Service*

A dispatcher, mobilizing his forces in the heat of an emergency; an inspector analyst, carefully reviewing the action on an extra-period fire; a research worker, attempting to determine the rate of spread for a given fuel type, all are vitally interested in the size of fires when first discovered by the lookout.

A glance at the fire reports serves to convince the most optimistic individual that our present methods of estimating the initial size of



Distance fire-perimeter scale.

fires are, to say the least, extremely inconsistent. On some forests the measurement of the smoke column by means of mil-scale glasses has tended to improve these estimates, but in most cases the personal opinion of the lookout, backed occasionally by a rule of thumb, has been entered on the reports without check or question.

It is undoubtedly true that an experienced lookout can estimate the size of a fire observed in seen area close to his tower within an allowable limit of error. It is also true that any lookout equipped with fire finder can measure the width of the smoke column, assume a diameter of 90 feet to the mile per degree, multiply the resulting figure by 3.1416, divide by the number of feet in a chain, and arrive eventually at an estimate of the perimeter of the fire.

The lookout can do this, but does he? The figures on our fire reports would seem to indicate that he does not.

The dispatcher's distance-fire perimeter scale illustrated is offered as a means of standardizing the estimates of initial fire perimeters, in order to aid both dispatching and analyzing. It is constructed on transparent plastacel, with a glass-topped pin fixed at the point marked center. It consists of:

1. A distance scale graduated in miles and identical to the scale of the dispatcher's azimuth map ($\frac{1}{2}$ inch = 1 mile, where this scale map is used).

2. A number of scales placed below this, but radiating from a common center, and graduated in chains of perimeter for fires located at varying distances from the observer, and with smoke columns subtended by angles of 5-minute variation.

We find, then, that a fire 9 miles distant, with a smoke column subtending an angle of 20 minutes would have approximately 13 chains perimeter, if of circular form.¹

In constructing this scale, the following formula is used:

$$\frac{\Pi}{C} \times \frac{b}{\cot A}$$

$\Pi = 3.1416$, the circular constant.

$C = 66$, the number of feet in a chain.

b = the map distance from tower to the fire.

$\cot A$ = cotangent of the angle subtended by the smoke column.

In using this scale, the dispatcher:

1. Secures from the lookouts the normal azimuth readings, and the angle subtended by the smoke column, measured to the nearest 5 minutes.

2. Plots the cross shots in the usual way. He then sticks the perimeter scale center pin at the map location of the fire, rotates the scale until the line of the angle read intersects the map location of the tower.

3. Directly below this point he reads the perimeter of the fire in chains.

4. When smoke column readings are obtained from two or more lookouts, the same procedure is followed, except that the final perimeters are averaged.

Where a glass-topped table is used by the dispatcher, it will be found advisable to make up the perimeter scale with a center pin the same size as the protractor. The scale is then used by placing the center pin in a tower hole and rotating it until the angle line intersects the map location of the fire. It will be noted, however, that where two towers submit readings, this method of using the scale requires two set-ups against one for the system previously mentioned.

While it is realized that this scale will not prove absolutely accurate in all cases, it is believed that by concentrating the responsibility for the estimation in the hands of the dispatcher, and furnishing him a tool for the job, much inconsistency in the records will be eliminated.

¹ Records show that most fires in their early stages are circular or oval, tending to become irregular as they increase in size.

MODIFICATIONS OF THE CALIFORNIA PROFILING BOARD

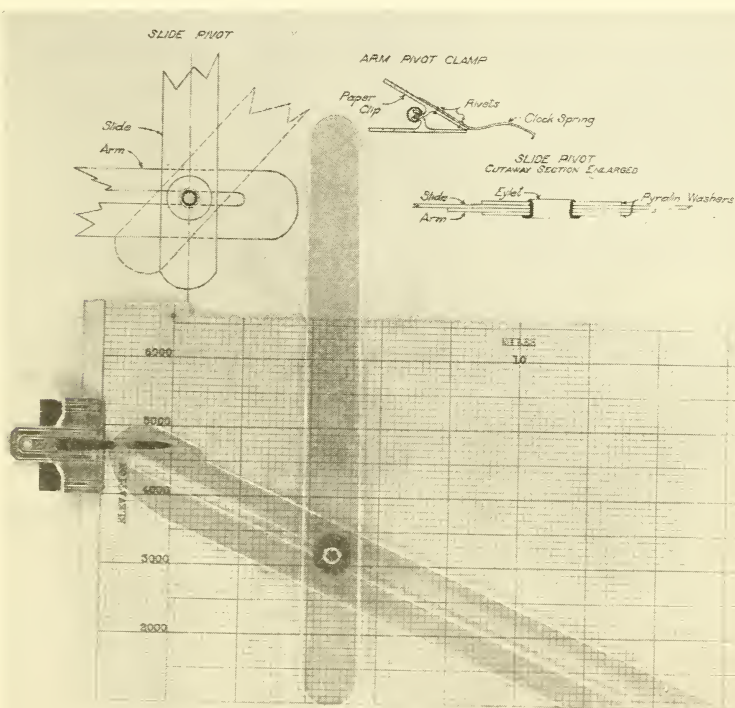
BROOKE R. DAVIS

Junior Forester, Cherokee National Forest

The modifications of the California Profiling Board ² herein described and illustrated consist of an arm-pivot clamp and a slide secured to the arm by means of a movable pivot.

When two points, differing but 50 or 100 feet in elevation, are to be mapped with the profiling board, it is often difficult to pierce the board at the exact elevation desired without breaking over into a previously used arm pivot hole. The arm-pivot clamp is not only very easily and quickly placed on the exact point desired, but also obviates the necessity of piercing holes in the profiling board.

To make an arm-pivot clamp, flatten the sides of a number 10 Esterbrook paper clip; then rivet a small section of clock spring or other resilient metal to the side of the clip, as indicated in the diagram.



Arm-pivot clamp and slide pivot for profiling board.

² Described p. 7, U. S. Department of Agriculture Circular No. 449, "Planning, Constructing, and Operating, Forest-fire Lookout Systems in California", by Show, Kotok, Gowen, Curry, and Brown.

The parts of a pivoted slide are all made of pyralin and of any size that is best suited to the scale of the map in use. Before crimping the eyelet with eyelet pliers, it is suggested that a piece of paper be inserted on the inside of each washer and then removed after the eyelet has been crimped, thus insuring ample clearance to allow for freedom of movement of the pivot on the arm.

For accuracy, efficiency, and ease in profiling, some form of perpendicular slide is obviously necessary. The pivoted slide described has proved to be exceptionally convenient to handle and of very material aid.

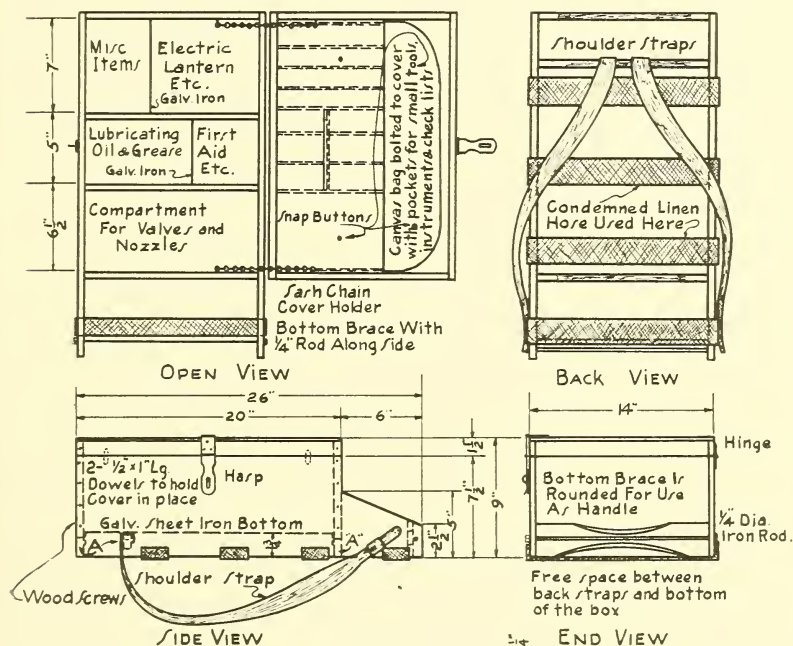
POWER PUMP ACCESSORY BOX

R. G. SETTERGREN

Superior National Forest, Region 9, U. S. Forest Service

The need for an accessory box for the power pumps on the Superior National Forest has long been felt. The packsack was formerly used for the accessories and tools, but was not very satisfactory as the equipment was always in disorder, making it necessary to remove

POWER PUMP ACCESSORY BOX WITH BUILT IN PACKFRAME



MATERIAL REQUIRED

- 2-Pcs. 5/8 x 7 1/2 x 26 Lg. "D" select Pine
- 2-Pcs. 5/8 x 1 1/2 x 20 Lg. " " " "
- 2- " 5/8 x 1 1/2 x 12 1/2 Lg. " " " "
- 4- " 6 x 12 3/4 3/8 Ply Wood
- 1- " 1/4 x 14 x 20 Lg. " " "
- 1- " 14 x 20 Lg. Galv. Sheet Iron 20 Gauge & 2 short
- 2- " 1 x 2 " Butt Hinges
- 1 Safety Hinge Harp
- 1 1 1/4 " Buckler With Keeper
- 2 6" Lg. Sash Chains
- 3 1/2 " Snap Buttons "Complete"
- 6 1/8 x 1/2 Lg. R.H. Bolts & Nuts
- 12 1/8" Washers

Top & Bottom Cross piece marked "A" to be cut back as shown

nearly everything in order to find what was wanted. Usually after every fire there was loss of tools and damage to the accessories because of the method of packing and lack of accountability.

During the last 2 years I have seen several types of accessory boxes and have made two or three of my own, but none of these boxes has proved entirely satisfactory. We have now developed, with the aid and suggestions of the supervisor and regional office, a combination accessory box and pack frame. We believe this will be entirely satisfactory for proper packing of accessories and tools, inasmuch as partitions in the box and canvas tool kit will keep all equipment in an orderly manner, readily accessible, and easily accountable, as each piece of equipment has a designated place.

The box weighs 16 pounds when constructed as shown on the accompanying sketch. The sides and ends are made of "D" select pine finished to $\frac{5}{8}$ -inch thickness and 8 inches wide. The bottom of the box is made of 28-gage galvanized iron recessed 2 inches to give clearance for the back in packing. The cover and two partitions in the box are made of 3-ply, $\frac{3}{8}$ -inch plywood with the short partition of 20-gage galvanized iron. The galvanized iron partitions are readily removable as they are slotted in by making a cut with a hack saw about $\frac{3}{8}$ of an inch deep. The box is put together entirely with screws, using $1\frac{1}{2}$ -inch No. 8 flat-head screws for the box and $\frac{5}{8}$ -inch No. 8 screws for the cover. The two plywood partitions are nailed in as is the bottom, cleats being used to recess the bottom.

The size of the box itself is 14 by 20 inches, outside measurements, but it was necessary to extend the two side boards 6 inches in order to get ample length on the pack frame. The sketch shows that one end and the brace between the two tailpieces are rounded $1\frac{1}{2}$ inches in order to give back clearance. The brace is rounded on the top for a hand grip while moving around in the warehouse. This is further strengthened by a $\frac{1}{4}$ -inch rod, as shown in the sketch, so the brace will not have a tendency to pull out when the box is carried in the hand.

The tool kit is made of 12-ounce duck, slots sewn for each individual tool, a flap covering the tools, either tied or snapped to hold the tools in place while in transit. This kit is firmly bolted to the cover by six stove bolts.

Condemned $1\frac{1}{2}$ -inch linen fire hose tautly stretched and firmly secured with $\frac{5}{8}$ -inch screws makes a very acceptable back support on the pack frame. Four pieces of this hose spaced 3 inches apart are sufficient, as it is not necessary to have any on the top, as the frame does not rest on the back. The shoulder straps are made of 2-inch webbing secured 6 inches from the top of the frame with leather straps and buckle, for adjustment at the bottom.

One important feature in the design of the box and the attachment of the carrying straps was to get the correct balance to give ease in carrying. After several trials and tests it was found that the load (or box of tools) should be set so it will rest high on the frame when carried. This accounts for the peculiar shape and design of the unit.

The accessories for the power pumps possibly vary between forests and regions, but we have tried to limit the accessories and tools to a minimum so as to reduce weight. The total weight of the accessory box fully equipped is 60 pounds. Following is a list of tools we feel are needed and which can be packed in the box:

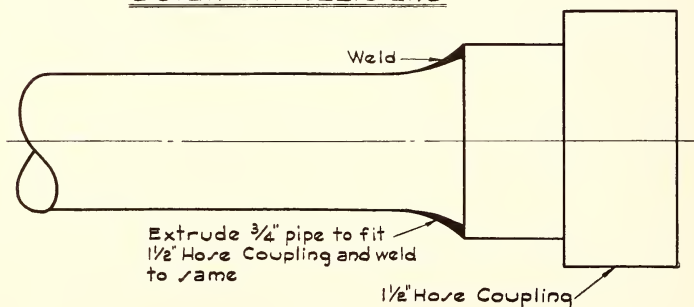
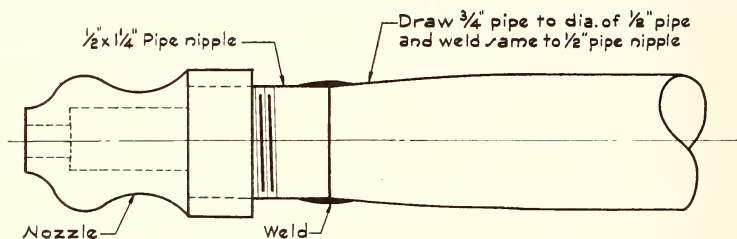
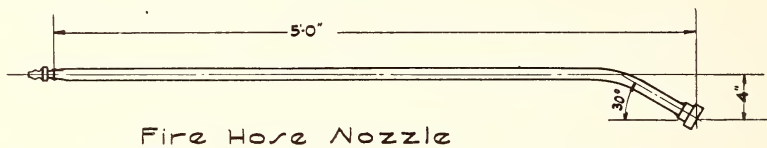
- | | |
|--|--|
| 1 cost operation book. | 1 pliers, 6-inch auto. |
| 1 crescent wrench. | 1 pack cover, canvas, 3 by 3 feet. |
| 1 electric lantern. | 1 screw driver, 4-inch. |
| 1 funnel, filtering. | 3 spanner wrenches. |
| 1 file, magneto. | 2 spark plugs, extra. |
| 1 first-aid packet SDO. | 2 Siamese valve couplings. |
| 1 gas-line hose, flexible rubber. | 1 suction hose (strapped on outside of box). |
| 1 grease cup, 1-pound can. | 1 suction hose strainer. |
| 20 hose gaskets. | 2 starting cords. |
| 1 instruction for operation. | 1 stovepipe wire (small coil). |
| 1 lubricating oil, in 1-quart can with inverted spout. | 4 car seals. |
| 2 nozzles. | 1 wiping rag (bundle). |
| 1 pencil. | 1 copy list of contents. |
| 1 packing nut wrench. | |

The list will fit into the pocket on cover or can be tacked on the cover if preferred.

LONG FIRE-HOSE NOZZLE

Ottawa National Forest, Region 9, U. S. Forest Service

The accompanying illustration shows a long fire-hose nozzle for use with 1½-inch hose. This nozzle has proved very valuable for use on deep burning peat fires or for mop up of fires in roots or other deep materials. It was developed by members of the Minnesota State Division of Forestry, and several forests in Region 9 have adopted it as part of their pumper equipment.



Interchangeable ¼ or ⅝ inch nozzle tips
as mfg. by Pacific Marine Supply Co.
Seattle Washington.
Design of Fire Hose Nozzle by
State of Minnesota

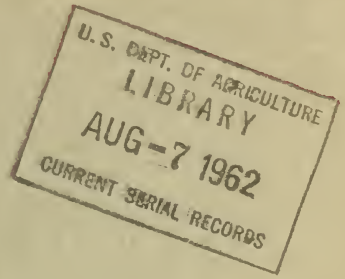


FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technology may flow to and from every worker in the field of forest fire control.

Reserve

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FIRE CONTROL NOTES



A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

INFORMATION FOR CONTRIBUTORS

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FIRE CONTROL NOTES

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The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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ADAPTING THE CONFERENCE TO FIRE CONTROL TRAINING

R. C. LINDBERG

Training Supervisor, Region 6, U. S. Forest Service

It is true, as the author says, that contributions on training have been very limited. This is a reflection of lack of balance in fire-control thinking and practice. One of our acute needs is to build up the body of understanding, skills, and practice and bring training up to the relative level of advancement attained in aerial delivery of supplies or construction of detection improvements, for example. The author takes up one training device which we have used with more enthusiasm than judgment. If his article provokes others challenging accepted practice or reporting suggestive experience in training for fire control, this vital activity may begin to catch up.

Possibly "more line has been lost" in use of the conference than in other training methods.

Some 20 years ago inquiring minds recognized the potential training value of the conference, analyzed its pattern of procedure, and formulated what might be considered a set of rules for conducting a conference. Forest officers have used the conference method to some extent for the last few years in connection with guard training and with overhead in suppression training. Results have varied from highly satisfactory to a total loss.

So the questions: What are the more common criticisms of the conference as it has been used in fire-control training? What are the underlying reasons contributing to unsatisfactory results? What adaptation can or has been made to increase its efficiency as a training tool?

The enumeration of the following criticisms, it should be clearly understood, is not a blanket indictment of all past conference training, but rather a necessary step in seeking ways for improvement:

1. Some conferences do not begin anywhere, go anywhere, or end anywhere.

2. The procedure is too time-consuming.

3. Conferees lack experience in or knowledge of the subject in which training is intended.

4. The conference leader puts a question on the board; after which he frantically attempts to record everything that is said. No summarization is made. It ends, leaving the question, "So what?" in the minds of trainees.

5. The leader does most of the talking.

Certain key reasons must be more or less responsible for all of the criticisms listed. Personal experience and observation indicate there are three reasons of major importance:

- (a) Lack of training and experience in conducting a conference.

It is difficult to determine just when and where and how the conference method of training was chosen and first used in fire-control

training. It seemed applicable for certain training situations, and in the course of time instructions for conducting a conference appeared in training handbooks. But, as a rule, conference leaders in fire-guard or suppression training have not received any great amount of training in either planning or conducting a conference. As the time for the guard-training camp approaches, instruction assignments are made. Certain instructors are faced with leading a conference. One type, the optimist, says, "It's a cinch." He makes no preparation. Refer to criticisms 1, 2, 4, and 5 for the probable outcome. The second type, very conscientious, makes a plan for his conference so rigid that no alternatives are considered or tolerated. He finds that conferees do not react the way they were supposed to, nor say what the plan calls for. Refer to criticisms 2 and 5 for the probable outcome. The third type comes through and does a pretty good job, and it is said that he has natural ability.

(b) The conference leader, both in planning and execution, is more concerned with conference technique than training objective.

Forest officers want to do things right. They want to lead a conference properly. With limited training and experience they are, in some respects, in the same fix as the student flyer taking his first few lessons. He is so occupied with the mechanics of flying the ship, "keeping the nose on the horizon and the wings level," that he loses all sense of direction and destination. With continued instruction and practice, conscious attention given to controlling the ship decreases and proportionate time is gained for selecting route of travel and destination.

The thinking of the forest officer leading his first few conferences is probably along this channel: "I have to lead a conference"—his preparation; "I am going to lead a conference"—his performance; "I am leading a conference." All of this submerges the principal idea, "I have a training job to do and I will make use of the conference in attaining my objective." Instruction and supervised practice are partly the answer, but a clearer perception of objective is needed, which leads to the final reason for criticisms of the conference method of training.

(c) The lack of a tangible objective for training in such subjects as fire prevention, the duties of a foreman or fire-camp manager, and strategy as applied to fire suppression.

Training of this type differs from training in how to use a shovel or an axe in that it is, for the most part, mental training. In practice, it involves sizing up situations (analysis), planning, and action.

A safe approach in training is to begin with the premise that thought precedes action, and that day-to-day action is governed more than is realized by *past experiences*. Where an individual's own experience is lacking or limited, he turns to someone who has had the experience which he believes will be helpful. A logical conclusion is that the decisions made, the action taken in any given situation, will be correct in proportion to past experiences in similar situations. Where experience is lacking, the most valuable guide to correct action is lacking.

A tangible objective for training, then, may be simply to design training situations which will provide the learner with simulated real experiences which he can use as a guide to correct action in the performance of his job.

In such an approach to training it is evident that the most careful consideration will have to be given to plans and physical preparation. The measuring stick for effectiveness of training can be easily applied: Is the learner being given experience in analyzing problems, sizing up situations, making observations, reaching conclusions, making decisions, taking action in circumstances which approach the actual as nearly as possible?

The conference method has a useful place in a training program designed to simulate real experience, but it must be used only as a training device—as the occasion demands, dropped for some other method, and used again. There is great need to break away from the stereotyped manner of conducting a conference. There is greater need for making the training situation more realistic. In this connection, it is possible to make use of sketches, relief maps, enlarged aerial photographs, moving pictures, models, cases, problems, and field demonstrations. The use of these devices, of course, takes preparation, but of what value is a training program that does not get results?

The following illustrations have been designed to show how a program simulating real experiences might be carried out:

On the subject of fire prevention.—Planning begins with an analysis of the situation. Certain facts are known, such as: Over one-half of all fires are man caused—by different types of people, and for different reasons. Further analysis determines types and reasons. The problem is to find a hub to which the spokes of a prevention program can be anchored. It is a trait of human nature to consider any proposition in terms of, "How is this going to affect me"? To be successful, the fire-prevention program must in some way sell a *gain*, rather than a *loss*, in personal advantage.

The objective of training is to give forest officers a background of experience in (1) analyzing and classifying prevention problems, (2) finding solutions which offer a gain in *personal advantage* to individuals or classes of people, and (3) the salesmanship to put it over. Preparation for group training to reach this objective will include assembling a variety of *cases* (real or hypothetical), *problems*, *solutions*, and method of *transmittal*.¹ The conference method can be used in group analysis of problems, examining given solutions of problems, analyzing proposed solutions of problems, and proposed method of transmittal by individuals of the group. During this training process, the conference would simply serve as a device to guide and stimulate thinking toward the right answer. Advance assembly of material as suggested saves time, otherwise frequently wasted, in focusing group attention on a specific problem. Most important, it leaves in the minds of the group a feeling of having participated in what amounts to an actual experience.

Foremen play an important part in the fire-suppression job. They direct the work of from 25 to 50, or more, fire fighters. All have observed, or perhaps conducted, foreman-training conferences where the instructor placed on the board this question: "What is the foreman's job?" Duties were listed and maybe their relative importance discussed. Such procedure would be all right as a starting point in

¹ Transmittal means the manner in which the idea is conveyed, such as through personal contact, addressing a group, printed material, pamphlets, posters, etc.

foreman training, but too often that is all there is to it. In terms of experience on which the foreman can draw in actual practice, there is almost nothing.

There are ways of doing a better training job. For example, the foreman is concerned with "fire-line location" and "adequacy of fire line." Instead of talking about it, why not in advance of training build a piece of fire line in relation to a plainly marked hypothetical fire boundary and, for instruction purposes, stake it off in 100-foot units. Careful planning would make possible incorporation of both good and bad practice in location and construction of the line.

Instead of discussing line construction in the conference room, the instructor would take the foremen class over one unit of the demonstration line, at which time he would point out and give supporting reasons for good and bad practice. The class, working individually, would then inspect a unit of line and make brief notes. Later the instructor and the group as a whole would go back over the unit and discuss location and adequacy of fire line, point by point. In so doing, the instructor would in an informal way use the conference method in drawing out reasons, in promoting analytical thinking, in arriving at correct conclusions as to good practice. The procedure would be repeated for the next unit of demonstration line, and so on. The instructor's objective would be to develop the foreman's ability to size up and analyze situations, to arrive at sound decisions as to good practice; and, in effect, provide the foremen with a background of experience which would be vivid enough to be retained and which consciously or unconsciously would guide each individual in future actual situations. Training in certain other phases of the foreman's job could be handled similarly.

Fire-camp managers (camp bosses) are sometimes responsible for selecting the specific location of the fire camp, but are always responsible for laying it out. Again, instead of talking about these duties, and calling it training, would it not be better to get out in the field and do something about it? To illustrate: The instructor would take his group, who are to receive training as camp managers, to a previously determined location where he would describe the boundaries of a supposed fire and explain certain guiding principles on camp location and the reasons for each. Then he would take his group to two or three possible locations for a fire camp. Locations would be discussed on the ground, and conclusions reached as to the strong and weak points of each. During the discussion the instructor would use conference procedure in clinching fundamental principles on fire-camp location.

The same plan could be followed during instruction in fire-camp lay-out (the relation between location of kitchen, storage of supplies, truck yard, tool dump, bedding-down grounds), starting with the inspection of a previously laid out fire camp which would demonstrate good and bad practice. During and following such inspection the instructor would explain certain basic principles in fire-camp lay-out. To give the trainees experience, they in turn would be given the job of staking out additional camp lay-outs; after which their work would be inspected by the group as a whole under the guidance of the instructor.

Fire-suppression strategy training becomes increasingly important as the number of large fires decreases through improved fire-control

technique. As in the Army and the Navy, pseudo experiences will have to be substituted for actual experience. In this training is limited to slash disposal for actual practice with fire behavior.

The critical review of action taken on past fires is a valuable training medium. The conference method can be used to good advantage in such reviews. Time will be saved if good sketches of the day-to-day maps of the fire under discussion are prepared in advance; likewise by having individual copies of memoranda outlining action taken on the fire and other pertinent data.

Greater use of enlarged aerial photographs, relief maps, or carefully prepared sketches will make problems more realistic and help each individual in the class to see them in the same light. Conference procedure can be used to promote analytical thinking by drawing out all angles of the problem involved and to crystalize conclusions as to fundamentals of sound fire-suppression practice.

The illustrations given attempt to show how the conference may be better used as an aid in training, wherein *emphasis will be placed on reaching the objective of training* rather than on the method. With adequate carefully planned preparation for each training job, the time consumed in training will be decreased and the desired results obtained.

And finally in all the planning and preparation this question should be kept in mind: Will the training proposed leave the trainee with experiences on which he can draw as a guide to proper action in the job he is going to do?

It Can Happen Here and There.—The 323-acre Sibley Creek fire on the Mount Baker National Forest was one of those fires where everything seemed to click and no suggestions are made for improved action. The days this fire was burning were extremely hot, temperatures of 110° were reached with a minimum of 15 percent humidity. The one-lick method was employed, resulting in fast corral.

In estimating the manpower for first-period control, provision for relief crews was delayed with the result that men used in initial attack were greatly overworked. The one-lick crew started at 4 a. m. and established corral at 10 a. m., but since no reserves were on hand, this same crew maintained control until 6 p. m., when relief crews arrived. While they were successful, it might easily have resulted in a serious situation from attempting to hold line with a weary crew. In calculating probabilities, serious consideration should be given to the employment of reserves to relieve the corral crew when they have achieved corral, but are too exhausted to continue. The present formula for making calculations does not specifically provide for this situation.—C. C. McGuire, acting supervisor, Mount Baker National Forest.

A New Reason for Man-Caused Fires.—The Hospital Rock fire on the Modoc National Forest was started about 4 a. m. by ranchers attempting to prevent frost damage to grain crops. The smudges they had prepared apparently did not make enough smoke, so they set a large number of fires in dry grass where they spread to national-forest and national-park land.

LARGER FIRES ON THE NATIONAL FORESTS

ROY HEADLEY

Division of Fire Control, U. S. Forest Service, Washington, D. C.

Among fire control men there is a real difference of opinion on the extent to which study should be concentrated on the larger fires as distinguished from all fires. Some men believe that by concentrating on the lessons to be learned from the relatively small number of fires which can be designated as "larger," much may be discovered which is likely to be missed by systems of analysis and study which include all fires. Others believe that concentration of attention on large fires is dangerous and may result in neglect of the methods and principles which are of importance in keeping small fires from becoming larger.

As is so often the case in such issues, the answer is probably a matter of proper balance. Both classes should be studied. Failure to review the action taken on even the smallest fires invites weaknesses that will let more little ones grow into big ones. But larger fires have characteristics peculiar to themselves. Management of the larger fire jobs is a rather distinct branch of fire control—and a backward branch. Failure to study the action on these larger fires invites weakness that will let big ones grow into bigger ones. These bigger ones hurt, too. Out of a total of 219,000 acres burned in 1938, 35,000 acres were lost in one fire. Seventy-five thousand acres were lost in the four largest fires.

TABLE 1.—*Number of larger fires and area burned by them inside national-forest boundaries*

	R-1	R-5	R-6	R-2	R-3	R-4	R-7	R-8	R-9	Total or average
Number of larger fires:										
1936.....	11	21	4	5	3	1	3	29	28	105
1937.....	4	11	7	2	1	3	1	20	13	62
1938.....	3	19	13	1	4	1	1	25	6	73
Average.....	6	17	8	3	3	2	2	25	16	80
Percent larger fires are of total fires:										
1936.....	0.6	1.2	0.3	1.2	0.2	0.1	0.4	0.7	0.7	0.6
1937.....	.3	.7	.5	.6	.1	.3	.3	1.1	.7	.5
1938.....	.2	1.1	.6	.3	.3	.2	.3	1.0	.2	.5
Unweighted average.....	.4	1.0	.5	.7	.2	.2	.3	.9	.5	.5
Area burned by larger fires:										
1936.....	41,924	68,842	3,504	15,227	2,583	1,600	2,673	26,616	71,695	234,664
1937.....	1,474	12,487	4,548	2,435	410	4,048	785	13,386	8,178	47,751
1938.....	1,319	60,879	60,395	664	3,810	900	473	15,835	2,286	146,561
Average.....	14,906	47,403	22,616	6,109	2,266	2,163	1,310	18,612	27,366	142,992
Percent area burned by larger fires is of total area burned by all fires:										
1936.....	90.4	88.0	39.3	94.7	47.9	38.7	84.0	18.8	26.8	58.7
1937.....	42.4	75.9	81.8	83.4	21.0	66.6	20.5	36.5	35.8	51.5
1938.....	50.8	92.3	92.9	51.8	62.8	47.7	12.6	33.9	8.9	50.4
Unweighted average.....	61.2	85.4	71.3	76.6	43.9	51.0	39.0	29.7	23.6	55.3

Special reports are now available on larger fires for 3 years—1936, 1937, and 1938. Unfortunately, these reports cover fires of over 500 acres for 1936 and fires over 300 acres for 1937 and 1938. To avoid annoying repetitions of this difference in the following pages, the distinction is ignored and the term "larger fires" is used for both those over 500 acres in 1936 and those over 300 acres in the 2 following years. This fault should be kept in mind in reading the figures.

It is of some interest to note that of the total of 73 fires over 300 acres in 1938, 28 were between 300 and 501 acres. Seventeen of these were in the 3 eastern regions. In 1937, with a total of 62 fires over 300 acres, 23 were between 300 and 501 acres. Sixteen of these were in the 3 eastern regions.

TABLE 2.—*Averages of size, perimeter, output of held line, discovery time, and travel time for larger fires*

[While averages usually mean little by themselves, they sometimes disclose trends and major variations reliably]

	R-1	R-5	R-6	R-2	R-3	R-4	R-7	R-8	R-9	Un-weighted average or total
Average size of fires (acres):										
1936.....	3,811	3,278	876	3,045	861	1,600	891	918	2,561	1,982
1937.....	369	1,135	650	1,218	360	1,349	785	669	629	796
1938.....	440	3,204	4,641	664	953	900	473	633	381	1,365
Average.....	1,540	2,539	2,056	1,642	725	1,263	716	740	1,190	1,361
Average perimeter of fires (chains):										
1936.....	1,426	1,163	1,190	1,240	467	560	633	594	1,277	950
1937.....	451	710	503	928	283	1,187	518	481	535	622
1938.....	600	807	1,519	776	563	520	295	633	372	676
Average.....	826	893	1,071	981	438	756	482	428	728	749
Total of perimeters of all larger fires (miles):										
1936.....	196.0	305.4	59.5	77.5	18.3	7.0	23.8	215.4	446.9	1,349.8
1937.....	22.6	97.6	44.0	23.2	3.5	44.5	6.5	120.3	87.0	449.2
1938.....	22.5	191.7	246.9	9.7	28.0	6.5	3.7	188.5	27.9	725.4
Average.....	80.4	198.2	116.8	33.5	16.6	19.3	11.3	174.7	187.3	841.5
Average output of held line per man hour from start of work to completion of control line (chains):										
1936.....	0.09	0.15	0.14	0.12	0.23	0.60	0.04	1.24	0.06	0.30
1937.....	.11	.22	.03	.11	.71	.31	.67	2.97	.46	.62
1938.....	.13	.07	.04	.29	.06	.10	.28	1.57	.69	.38
Unweighted average.....	.11	.15	.07	.17	.33	.34	.33	1.93	.40	.43
Average elapsed time from start to discovery (minutes):										
1936.....	146	22	12	2,816	990	30	125	33	690	540
1937.....	¹ 2,807	¹ 1,733	¹ 2,831	¹ 1,522	¹ 1,040	¹ 1,063	675	44	423	¹ 1,349
1938.....	22	74	160	5	175	1	5	75	18	59
Unweighted average.....	992	610	1,001	1,448	768	365	268	51	377	649
Average travel time (minutes):										
1936.....	57	39	50	32	72	15	63	30	73	38
1937.....	166	170	76	40	360	280	100	38	167	155
1938.....	28	399	205	10	153	15	15	24	46	99
Unweighted average.....	84	203	110	27	195	103	59	31	95	97

¹ Lightning fires.

TABLE 3.—Area burned in relation to travel time to larger fires

	R-1	R-5	R-6	R-2	R-3	R-4	R-7	R-8	R-9	Total
Area burned by fires where travel time was 15 minutes or less (acres):										
1936.....	25,777	16,275	1,482	8,056	668	1,600	0	13,606	22,149	89,613
Percent above is of total ¹	55.6	20.8	16.6	50.1	12.4	38.7	0	13.7	13.5	20.5
1937.....	351	3,790	946	1,181	0	0	0	1,913	0	8,181
Percent above is of total ¹	10.1	23.0	17.0	40.5	0	0	0	5.2	0	8.0
1938.....	395	16,539	3,597	664	0	900	473	3,362	301	26,231
Percent above is of total ¹	15.2	25.1	5.5	51.8	0	47.7	12.6	7.2	0.6	12.0
Area burned by fires where travel time was more than 15 minutes but not more than 1 hour (acres):										
1936.....	10,667	32,541	0	2,189	0	0	1,424	11,191	32,861	90,873
Percent above is of total ¹	23.0	41.6	0	13.6	0	0	10.0	11.3	20.4	20.8
1937.....	0	6,019	1,260	0	0	0	0	9,651	6,020	22,950
Percent above is of total ¹	0	36.6	22.7	0	0	0	0	26.3	23.5	22.4
1938.....	924	18,244	6,573	0	2,318	0	0	12,473	1,573	42,105
Percent above is of total ¹	35.6	27.7	10.1	0	38.2	0	0	26.7	6.1	19.1
Area burned by fires where travel time was more than 1 hour (acres):										
1936.....	5,480	20,026	2,022	4,982	1,915	0	1,249	1,819	16,685	54,178
Percent above is of total ¹	11.8	25.6	22.7	31.0	35.5	0	8.8	1.8	10.2	12.4
1937.....	1,123	2,678	2,342	1,254	410	4,048	785	1,822	2,158	16,620
Percent above is of total ¹	32.3	16.3	42.1	43.0	21.0	66.6	20.5	5.0	8.4	16.2
1938.....	0	26,096	50,225	0	1,492	0	0	0	412	78,225
Percent above is of total ¹	0	39.6	77.3	0	24.6	0	0	0	1.6	35.7

¹ Total referred to is total area burned for the year by fires of all sizes.

TABLE 4.—Area burned in relation to distance from a road to point of origin of larger fires

	R-1	R-5	R-6	R-2	R-3	R-4	R-7	R-8	R-9	Total
Area burned by fires where point of origin was $\frac{1}{2}$ mile or less from nearest road (acres):										
1936.....	31,779	65,029	3,504	13,798	668	1,600	866	26,099	58,992	202,335
Percent above is of total ¹	68.5	83.1	39.3	85.9	12.4	38.7	6.1	26.3	36.0	46.4
1937.....	351	6,899	1,416	1,181	0	0	785	13,386	6,730	30,748
Percent above is of total ¹	10.1	32.0	25.5	40.5	0	0	24.3	36.8	26.3	30.0
1938.....	1,319	32,402	10,170	664	502	900	473	15,835	2,286	64,551
Percent above is of total ¹	50.8	49.1	15.6	51.8	8.3	47.7	12.6	33.9	8.9	29.5
Area burned by fires where point of origin was $\frac{1}{2}$ to 1 mile from nearest road (acres):										
1936.....	0	3,813	0	1,429	0	0	0	0	723	5,965
Percent above is of total ¹	0	4.9	0	8.9	0	0	0	0	4	1.4
1937.....	0	454	0	0	0	0	0	0	0	454
Percent above is of total ¹	0	2.8	0	0	0	0	0	0	0	4
1938.....	0	0	0	0	0	0	0	0	0	0
Percent above is of total ¹	0	0	0	0	0	0	0	0	0	0
Area burned by fires where point of origin was 1 to 3 miles from nearest road (acres):										
1936.....	565	0	0	0	1,915	0	1,807	517	2,011	6,815
Percent above is of total ¹	1.2	0	0	0	35.5	0	12.7	.5	1.2	1.6
1937.....	803	1,927	2,142	1,254	0	3,028	0	0	1,448	10,602
Percent above is of total ¹	23.1	11.7	38.5	43.0	0	49.8	0	0	5.6	10.3
1938.....	0	20,922	3,855	0	0	0	0	0	0	24,777
Percent above is of total ¹	0	31.7	5.9	0	0	0	0	0	0	11.3
Area burned by fires where point of origin was over 3 miles from nearest road (acres):										
1936.....	9,580	0	0	0	0	0	0	0	9,969	19,549
Percent above is of total ¹	2.1	0	0	0	0	0	0	0	6.1	4.5
1937.....	320	3,207	990	0	410	1,020	0	0	0	5,947
Percent above is of total ¹	9.2	19.5	17.8	0	21.0	16.8	0	0	0	5.8
1938.....	0	7,555	46,370	0	3,308	0	0	0	0	57,233
Percent above is of total ¹	0	11.5	71.3	0	54.5	0	0	0	0	26.1

¹ Total referred to is total area burned for the year by fires of all sizes.

Lessons Learned

Such an infinite variety of problems are involved in the management of large fire jobs that thoughtful men seldom fail to learn from each one something which should be guarded against in the future, something which should be done differently, some cherished belief which must be modified or abandoned. For 35 years I have been working on or observing suppression jobs, but I still learn something from every fire I reach.

Sometimes, alas, we "learn the same lesson over and over"—or do we? For example, I have learned throughout many years that there is some flaw in our management of larger fires which keeps us from getting a reasonable output of held line from a crew of a given size. Plenty of other people have learned the same thing. But, untrained as we are in the science and art of management, we have not found ways to act satisfactorily on what we have learned. Our learning has too often failed to lead to productive action.

The first essential in such matters is to grasp the need for change, the nature and importance of a problem, the chance to introduce something better. With that fact in mind, the outline for 1938 reports on larger fires requested a record of lessons learned by the man or men who had most to do with each fire. Some of the most suggestive answers received are quoted in this article. Quotations from the remainder will be continued in the next issue of Fire Control Notes. All fire-control men may benefit by the lessons learned on these fires. Perhaps these notes will help reduce the number of times lessons have to be "relearned" by different men—or by the same men. Because of lack of space, the statements of problems and lessons learned are clipped short, thus inviting the reader to do his own thinking. Publication of the conclusions does not necessarily mean that I agree.

Northern Region

Absaroka—Chico fire—429 acres.—The fire got over the line because of incomplete mop-up and men being gathered in a bunch to get water. (That lesson must have been learned a thousand times.—Ed.) The foreman in charge was a young, inexperienced administrative guard who, in his zeal to be helpful, left his crew to help on another part of the line. Had he had more experience, he would have recognized that his crew lacked training and knowledge of fire fighting, and he would not have left them. This might also be traced to the fact that the sector was too long for efficient handling by the sector boss. The country was so steep that the man in charge could not cover his whole line often enough.

More education and follow-up will have to be taken to overcome the fire risk in this locality. (Fire started by hot ashes thrown in cheat grass.—Ed.)

Furnish Forest Service overhead for crews obtained from other organizations. Locally and through the regional office get a line-up of the ability and training of fire crews outside of the Service which may be called to fight fires.

Assign more sector bosses where the topography requires it.

The regional office should continue training overhead and the forest should ask for plenty even at the risk of overmanning.

Kaniksú—Goose Creek fire—544 acres.—An organization principle was violated in that authority on the ground was divided between two heads and coordination was not effected. Two men, either qualified to handle the entire fire, were on the job. Each assumed the other to be in charge. Each aggressively worked on opposite sides of the fire, expecting the other fellow to see that balance was maintained.

Too much confidence was placed upon the ability of human beings to function on their own under emergency conditions. Much training has been given our camp bosses. They know the fundamentals of camp management, but we must not assume that they will, without actual (and much) experience, perform efficiently without fairly close supervision. Merely instructing a "trained" man to "go ahead" is not enough. I have not that much confidence in people. Further, it is not fair to the subordinate.

More attention should have been given to securing lunches for two crews. Slow delivery of supplies from warehouses was partly responsible for the delay.

Kitchen arrangements at base camp were inadequate. Four hundred men were served the first breakfast from one mess line, and there should have been at least 3 lines, which would have eliminated the confusion and delay.

More and better scouting should have been done. Scouts were inexperienced and did not arrive soon enough causing a loss of an hour or two by misplacement of two crews. On the morning of September 5 more men were sent to one sector than were actually needed, making it necessary to move them to another sector later.

The men planning the attack were confronted by a fire burning very fast and throwing spot fires ahead. Fire was in a heavy, dry, white-pine slash area which had been logged during the summer and was pushed by a 20-mile wind. It was figured that the fire would travel in a northeasterly direction, which it did to a certain extent, but not as fast as was anticipated. Consequently, more men were figured for the northeast side than actually needed. If our foresight had been as good as our backsight, more men would have been placed on the west side where there were barely enough men.

From 50 to 75 C. C. enrollees were used for clearing and holding down the hot spots until the trenching machine came along. Although these men did more hand trenching than necessary, the machine trenched it over again, and had no trouble in keeping up with the clearing crew. In fact, I do not believe it operated over one-half of the time, because the crew could not keep ahead. Mr. Sutliff was in charge of the machine. He and a mechanic changed off operating it, and three C. C. enrollees assisted in pulling. About $2\frac{1}{2}$ miles of trench were built in 10 hours. Roughly, I would say that it did the work of 50 men.

Kootenai—Rocky Creek fire—380 acres.—The old story that an undetected spot fire blew up and caused this to be an extra-period fire holds true here.

In an analysis of the action on this fire by the supervisor, administrative assistant, two rangers, and an alternate and dispatcher who

were on this fire, it was agreed that the 25 men who were searching for spot fires were sufficient under the conditions that existed at the time of this fire. However, a spot fire got away, and caused the second run; therefore, the number of men or the organization of them must have been at fault.

Bulldozers were used to construct approximately three-quarters of a mile of line on this fire. The main criticism was on account of some of the burning fuel having been covered with duff and dirt which added hours to the time required to do the mop-up job.

The time of arrival, the rate of spread, and the size and value of the rapid-spread area determined the action to take. I believe a bulldozer line under not too difficult topographic conditions can be constructed in less time than any other machine we have on hand. The cost of mop-up is, of course, a problem, but corral is the first job. Because of the value of bulldozers, and the possibility of breakdowns, I recommend an extra machine on a fire-line construction job.

California Region

Angeles—San Antonio fire—3,270 acres.—We were slow in completing lines on some sectors, because of using crews too large—20 men per experienced crew leader. We should have (for this particular fire, and it is true in most fall fires that spread with erratic lines and many spots) used *small* crews, 5 men to each trained fire fighter, and made sectors small enough to provide closer supervision and more effective performance.

We learned that tank trucks should be of sturdier construction and completely standardized in design and operation, permitting change in operators and parts.

Should use paid tank-truck operators who are real mechanics and not rely on C. C. C. or temporary men. We had too many breakdowns and were short of trained operators.

New Pacific Y pumps were very effective. Could use lighter pump on three-fourth-inch hose effectively.

Tractors did a real job on this fire, particularly the RD No. 8. These should work in teams with a hoist on one, and they can be put almost anywhere. The RD No. 8 is far superior to any lighter models used. We would have used these more effectively if equipped with hoist.

Contour trails built by California Experiment Station on 1,000-foot intervals (for distributing rain gages) proved to be of great value in making accessible in a safe manner many long fingers in slopovers. We feel that contour trails on 500-foot intervals will become an important part of the Angeles protection plan on extremely steep slopes and in heavy cover. They need be only foot trails cleared 18 feet wide, but kept well cleared, and must not be blind trails, but have outlets both ways for safety.

Splendid cooperation by the United States Weather Bureau in their special fire-weather forecasts during the entire fire season, and specifically during the progress of this fire, made possible a more accurate planning program for fire personnel needs and strategy to be employed (particularly on backfire work).

Records show and this fire confirms: Our late fall fires are a problem we have not met in southern California. In the absence of early rains, in September and October we get Santa Anna conditions, extremely low humidity and high wind velocities up to 50 miles per hour. These conditions sometimes last a few days—sometimes 3 weeks. Practically all serious fires in southern California for the last 10 years have started under these conditions, indicating we have pointed our efforts to the normal season conditions and gained much ground, but now we must point to these abnormal fall conditions and plan to meet them by:

1. Study more intensively, the behavior of these late fall fires.
2. Provide 24-hour patrol and lookout service. This was a night fire—as have been two or three others.
3. Make more intensive use of closures regardless of private property interests.
4. Shorten elapsed time between discovery and first action by movement of equipment and men so as to concentrate in high hazard areas and high occurrence zones.

5. Intensify use of secondary lookout points.

6. Have night suppression crew on duty, dressed and ready to go.

In summary: Put *additional heat* on every control effort we normally practice for regular summer season.

Klamath—Slide Creek fire—4,117 acres.—Points of special significance on this fire were: First, the long travel time (12 to 17 hours) of crews going into this fire, with resulting high fatigue before going on to the line; and, second, the high resistance to control on the extremely dense vegetation characteristic of the Blue Creek drainage. Also, there is a decided lack of detection in this drainage. Night control can be obtained only by additional detection, more transportation facilities (roads) and crew attack.

Klamath—Red Mountain fire—500 acres.—This fire started within one-half mile of a point approved as a lookout station, which has not been constructed or manned to date because of lack of transportation facilities and funds.

Klamath—Potato Patch fire—550 acres.—It started on unprotected land outside the forest and a deliberate sacrifice was made to utilize natural barriers to corral that portion inside the forest boundary. In other words, the logical fire-control boundary does not coincide with the actual forest boundary.

Klamath—Red Cap fire—16,196 acres.—The suppression action on this fire was characterized by insufficient manpower and overhead in the first five burning periods, then a sudden build-up of men in a belated attempt to conform to the Forester's policy of immediate control. This sudden build-up led to placing more men in the field than could be adequately serviced—with consequent loss of efficiency. For example, on divisions 1 and 2, zone B, it took 400 men (including camp workers, etc.) 4 days to build and backfire 404 chains of line. Theoretically, 400 men should have built the line in 1 day, which would have been in accordance with the Forester's policy; but actually, they lost 50 percent efficiency because of lack of food and bedding; and it is estimated that about half of the remaining effort was dissipated in too wide line construction, so 100 men fully serviced and adequately supervised could have accomplished the same job in the same time.

The lack of sufficient men in the earlier stages of this fire resulted from three main causes: First, lack of speedy mobilization of available local laborers, because the machinery for mobilization was rusty through lack of use during 5 years of complete control by use of C. C. C.; second, failure to send in outside help; and third, scattered effort of available labor over 20 other fires that were starting or burning in the district at the same time.

To summarize, it is apparent that extreme effort should be made to satisfy the requirements of the Forester's policy as to control in the early burning stages. If the job continues to increase, there should be a reasonable adjustment of manpower needs to the point where they can all be adequately serviced and supervised.

Considerable difficulty was experienced at first through not having chutes prepared in advance. Considerable time was lost in trying to build chutes to exact specifications, until the urgency of the time situation led to simplification of the method of tying that was quite satisfactory. About a 10-percent loss was experienced through breakage and loss of chutes. On the basis of this experience, and a little experimenting this loss should be considerably reduced. The most interesting thing is that food could be delivered by airplane as cheap as by pack train. Use of special cargo planes with greater payload capacity should further reduce the cost.

Radio was used throughout the campaign—both ultra-high frequency and medium frequency sets. The ultra-high frequency was the most successful because of less interference and because of capable operation of the ultra-high frequency contact station at Orleans Mountain lookout. This station successfully handled 427 ultra-high frequency messages for five different fires in 14 days. The successful use of ultra-high frequency was also aided by a special stand-by unit used in connection with the T-set on Orleans Mountain which operated a buzzer when a set in the field turned on to the Orleans lookout frequency channel. This eliminated the necessity of maintaining schedules. The failures of the medium-frequency set were caused mainly by congestion of the one or two usable channels and by the lack of trained operators.

Radio has certainly come of age as a tool in fire suppression. Future application can be aided by making the present types of sets more efficient and simple, and through the unceasing efforts to keep a supply of well-trained operators available.

The Weather Bureau fire-weather field station forecasts were used throughout the fire. The assurance of this station that certain favorable conditions would continue made it possible to plan and construct a line into the head of the Red Cap Canyon, thereby saving about 4,000 acres that had appeared to be doomed.

The marvelous "do or die, stick to the bitter end" spirit of the short-term force was magnificent. It was with a feeling of deepest regret that with the first big rain storm on October 1 I was forced to dismiss them with the expressed hope that they could find enough to do through the winter to come back mentally and physically fit to tackle another season.

Los Padres—Messenger Canyon fire—520 acres.—Additional prevention contacts might have prevented this fire. It seems that the biggest problem confronting us today is to educate the public so that it

becomes a habit to be forever cautious of the dangers that exist if they are using lighted materials, whether a match to light a cigarette or the cigarette itself. The older we get the harder it is to break a bad habit and form a new one. Suggest therefore, that our efforts would be better spent on the younger generation. This suggests to us the need for more prevention effort in our schools. Too much of our time is spent with the adults when attention to the younger generation would pay more dividends in the long run.

Because of the shortage of organized manpower we need more mobile tractor-trailbuilder units to do the line-construction work. It is felt that we have not gone strong enough in this type of use to supplement the shortage of manpower on fires. The transportation problem and lack of competent operators seem to be our main obstacles at the present time.

There was just criticism of the acting dispatcher for not sending the Piedra Blanca crew first. As it turned out the Los Preietos crews were sent first and later the Piedra Blanca crew was sent and arrived on the fire ahead of the Los Preietos crew. There has been a tendency on the part of the field force to hold back the suppression foreman and crew to protect the immediate vicinity should another fire occur. Therefore, to clear up any question about this, the suppression crews and foreman are to be the first crews sent to a fire regardless of district lines. As these are our best trained men, there is more possibility of holding a fire to a small size. The dispatcher's judgment is final.

It was felt that the paper work involved to complete the forms necessary was not started soon enough with the men available. Later on, during the fire, too many high-powered men were employed on this work trying to bring them up to date. It was also felt that the accumulative report was too complicated and three men were appointed as a committee to study the possibility of a modification.

While advantage was taken of an old cabin at the fire camp, it was brought out that the location of the timekeeper in this cabin proved a disadvantage. Hereafter, he should be located out in the open as called for in the plan, where he can see the crews leaving and entering camp.

Eight 5-gallon pack cans were dropped over the fire by plane, with the following results: Four of the cans were so damaged that all the water was lost. It was felt that this was caused by the type of chute used—6- by 6-foot burlap squares. The water cans were packed in barley sacks filled with hay. It took two men 2 hours to get this equipment ready to drop.

San Bernardino—Arrowhead Fire—12,362 acres.—The Arrowhead Fire originally started in a cabin on the crest of the San Bernardino Mountain range. After very thorough investigation as to the cause of the fire, it is believed that it was due to faulty flue construction. The defect was believed to have been where the thimble fastened to the brick chimney.

Extreme fire weather conditions existed at the beginning of this fire and continued throughout. A high wind was blowing at gale force, 45 to 50 miles per hour, and the humidity was very low, about 7%.

The cabin in which the fire started had wooden, untreated shingles, also others that burned near this one. Due to the high winds the burning shingles were probably the greater cause of the many spot fires.

A prevention lesson may well be discussed now. It is very strongly believed that strict building restrictions should be enforced on private land which may be accomplished through State or county legislation. This problem may also be worked on through more frequent contacts of property owners by forest officers.

The rate of spread of this fire was extremely great during the first few hours. Approximately 8,000 acres burned during the first 7 hours or over 1,000 acres per hour.

Because of the high rate of spread it is doubtful that any means of preparedness in presuppression would have reduced the size of this particular fire. However, it was thought that we were deficient in the number of tank trucks available at the beginning of the fire and during the fire. A tank truck at Arrowhead ranger station would be very desirable and had there been one there it would have arrived on the fire about 7 minutes after the fire was reported instead of 36 minutes as was the case. Even though there had been a tank truck at Arrowhead ranger station, it is doubtful that it would have made any difference in this fire. But as a presuppression lesson we can see the importance of having favorable distribution of tank trucks.

All line constructed and lost was uncompleted line. All backfire work that was done was held although it slopped over in places. Orchard torches were used. No acreage was burned through back-firing which would not have been lost by the fire anyway.

Sequoia—Fish Hatchery Fire—500 acres.—Investigation shows that regardless of any suppression action taken after the crews arrived on the fire, it could not have been controlled while still small. This fire was simply moving too fast after it got up a headway. It is barely possible that had we been able to put about 50 men on this fire at the time the first crews arrived, the fire could have been held to a small acreage. However, there was no failure in first attack action, as the first crew traveling 10 miles, arrived 17 minutes after the origin of the fire. We feel, therefore, that the only way this fire could have been prevented from becoming large would have been for the district ranger to have taken such action earlier in the season as would have prevented the fire from starting. This might have been possible had he specifically designated a dumping ground for the use of the Kern County Juvenile Camp and had this ground thoroughly fire-proofed at the start of the season.

The fire was in very rough country where night work was difficult. District Ranger Stathem now believes that it would have been better business to have reduced his night crews in size, concentrating most of his manpower on the line during daylight hours.

The lower fire line was built paralleling an oiled road and in some places within 800 feet of this road. The reason for this was that it was believed at the time that it was necessary to do this to protect a high-voltage transmission line that was between the fire line and the road. Looking back on this, it is easily seen, however, that there was an opportunity to drop back to the road and hold the fire and also protect the transmission line with a much smaller crew, inasmuch as the line would have been easier to hold on the road.

Shasta—Salt Creek fire—1,690 acres.—The more important lesson that I learned from this fire was that it burned more rapidly at night, especially downhill, than I had thought possible, and as a conse-

quence, the fire made an advance beyond the point where it was estimated it would be held.

I believe the establishment and actual marking of stations along the fire line which corresponded to such stations shown on the fire maps were of great practical value in laying out and assigning divisions and sectors, preventing crews from getting lost, placement of radios, dispatching specialists, overhead and packers to specific parts of the fire line.

I did not learn from this particular fire, but rather had it impressed upon me again that one of our weaknesses of prevention is inadequate patrol, and the difficulty of getting a fire bug in the penitentiary.

Shasta—Wildcat Fire—550 acres.—I have a suggestion that may or may not be worth much. It is simply that a few words of prevention be used in connection with the large cigarette programs heard on the radio. To begin with, a large percentage of our man-caused fires are smokers' fires, also millions of people listen to the good cigarette programs. My idea is to have the radio announcer when he is telling how easy they are on the throat, etc., to say these few words in conclusion—"Before throwing them away, be sure they are out." If this idea is of any value, someone in the Washington office might interview the sponsors of these big programs and see what can be done in this method of prevention work.

Another suggestion for some cheap prevention work where millions of people would see it every day, is to show a colored slide in all movie theaters between features. A slide could be flashed on the screen screen saying "Be sure your cigarette is out before you throw it away. Thank you, U. S. Forest Service."

Shasta—Big Lake Fire—745 acres.—The most important thing I learned on this fire was that in slash type cover one should never try to attack the lead of a fire if it reaches an area of more than 3 acres. One should attack the rear first and pinch it in on both sides, putting the heaviest attack on the side toward which the wind is blowing.

Shasta—Another Big Lake Fire—425 acres.—One RD tractor used on this fire built line faster than 150 men could backfire and patrol.

The advantage of plenty of high-class overhead was one of the most important factors on speed of control on this fire. On every large fire we should get plenty of overhead as soon as possible.

One of the outstanding features on this fire was the placing of saddle and pack stock on the line immediately after the fire started. I believe that saddle and pack stock should be taken to all large fires as soon as possible to save overhead from a large amount of walking and to pack water and supplies to fire fighters.

Shasta—Mount Hedron Fire—8,300 acres.—This fire originated in a grass sage-juniper fuel type in gently rolling country at a time when the wind was blowing approximately 20 miles per hour. The fire was attacked by 20 men and 2 tank trucks within 11 minutes of its origin, and at that time it was about 3 acres in size and spreading rapidly. Cooperators were immediately called upon for help, but by the time they arrived the fire was completely out of control and was heading north before a strong gale wind.

The action of the fire indicated that it probably would have been a 300-acre fire even though there had been a full camp of CCC enrollees at Leaf which was only 8 miles away. It seemed to be one of those fires that had to make its run.

The fire (a smoker fire) would undoubtedly have been prevented had the hazardous bronco grass been removed from the highway right-of-way. This is a costly thing to do and we have not been able to secure satisfactory cooperation from the State Highway Commission to enable us to remove this annual hazard.

A Tractor-Trailbuilder Sit Down.—A trailbuilder was sent to this fire (name withheld) at shortly before noon of July 19, 1938, in the third period. It sat on the truck it came on and was not used until after I arrived on the fire and put it to work building line after the fire had been lost early in the afternoon of July 19. We could not have stopped this fire then without the aid of a trailbuilder. The last line we built was in an area of heavy winter storm damage full of down timber, reproduction, and broken tops. The fire was growing and coming too fast for this line to have been built by hand in time to backfire.—(Name of writer withheld).

Airplanes and Fog on the Green Mountain 1,500-Acre Fire on the Olympic National Forest.—An attempt was made to establish airplane camps in the back country on this fire, but because of fog which filled in during the second night this was impossible. To me this is significant. Airplane use on this forest will always be uncertain because of the rapidity with which fog banks form around the mountains and because of the extremely rough topography which forces planes to fly at a height that makes accurate work very difficult.—Vondis E. Miller, assistant supervisor, Olympic National Forest.

Cooperation or Incendiarism (name of forest and writer withheld).—Local cooperators were on this fire before Forest Service men arrived. This may be a healthful condition—or it may be a very bad situation. The area was, years ago, a very bad incendiary region. Numerous men in this area were then used on various fires all season. We still have to determine whether we are beginning to experience a recurrence of that incendiary situation. If so, we should obtain the confidence of some of the locals or place a law-enforcement man in the area to reside and have him determine what we are up against. If no incendiarism exists, then the cooperators should be praised highly for their work.

RECORDING PUMPER DATA ON A TOPOGRAPHIC MAP

J. CARLISLE CROUCH

Chief Ranger, Crater Lake National Park, U. S. National Park Service

Too often the story is: "We eventually found water and put pumps to work. If this could have been done sooner, the first and second breaks would not have occurred." The location of water supplies as a part of advance planning and the predetermination of the efficiency of pumping equipment as described by Mr. Crouch will help to get the pumps going sooner.

Reconnaissance and scouting of the area in which a going fire is located, as well as memory and field observations made in the past have been relied upon to determine if, when, and where water may be used by means of portable, high-speed motor pumps. Such methods of determination obviously have many disadvantages and have necessarily resulted in some lost motion and effort in fire suppression, insofar as the use of water is concerned.

To combine the use of water with other fire protection facilities and to provide a simple reference to predetermine its actual and potential use on fires, we here at Crater Lake National Park have devised and prepared a pumper-data map to be used in conjunction with other fire-protection data maps.

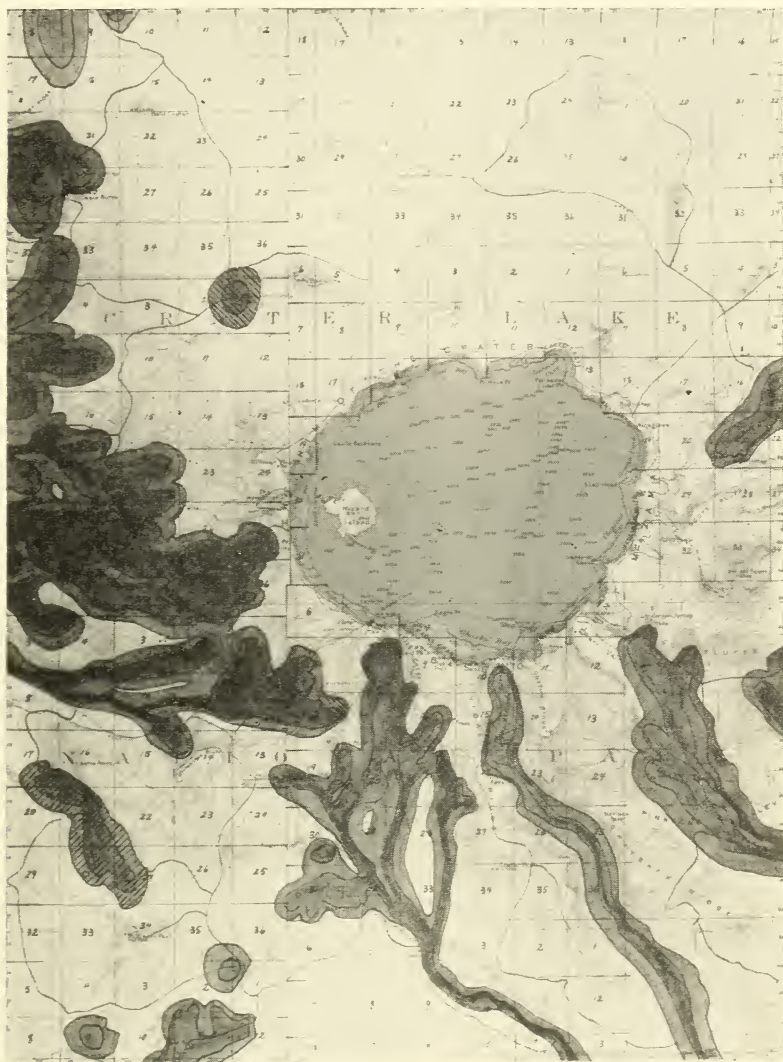
Extensive field studies were made to discover, to locate accurately, and to record sources of water suitable and sufficient for pumper use. These field data were recorded on a topographic map of the park area. Then the pumping efficiency of the equipment, based on the mean elevation of the park above sea level, was considered and tested, and this mathematical information was added to the map, so that not only was the location of the water supplies shown, but also the area which could be covered by the pumper.

The coverage of a pumper set up for action at the source of the water was determined conservatively as a horizontal distance of 1,500 feet and a vertical distance, outlet hose and with a minimum of suction, of 300 feet. The horizontal distance for the second pumper was determined as 1,500 feet, but with a vertical distance of 250 feet.

All of these data were applied to the map by means of different colors, one color to distinguish the area covered by one pump and another color to indicate the area covered by the second pump.

The map was designed for and used primarily by the dispatcher in his follow-up activities. Used in connection with the other fire-protection maps, it indicates readily and with reasonable accuracy whether or not one or more pumps may be used, the timber types, and the ease and efficiency with which the equipment may be employed. In spite of the fact that a considerable area of the park might be reached by motor pumps, this equipment is not substituted for fire fighters; but rather works with them, not for them.

The preparation of the map was not only interesting, but most helpful in formulating fire-protection plans. It will, no doubt, prove a valuable complement of the fire-protection data now available.



Topographic map showing pumper data. The inner darker area is located within reach of one pumper, the outer darker area can be reached with two pumpers operating in tandem. The cross-hatched areas are located within reach of water supplies which are not dependable for pump operations throughout the fire season.

LESSONS FROM LARGER FIRES ON THE SISKIYOU

L. L. COLVILL

*Assistant Forest Supervisor, Siskiyou National Forest, Region 6,
U. S. Forest Service*

A 3-day electrical storm in July 1938 started more than 60 fires on the Siskiyou—an all-time high for this forest for concentration of lightning fires in time. The spring had been exceptionally dry; winds were ruinous; the country was rough; and there was a serious lack of roads. Before the resulting "war" was over the 5 fires of more than 300 acres in size had burned over 48,000 acres—22 percent of the total area lost on all the national forests. The author was in charge of the largest of these 5 fires—the Chetco or Cedar Camp fire. Inspectors, who usually find many things wrong, could find no serious fault with his management of the job. But the fact remains that it took 26 days to corral the fire, which finally grew to more than 34,000 acres. Such fires afford priceless opportunities to learn the art of fire-suppression management.

Several important lessons were learned on the five large fires which occurred on the Siskiyou National Forest in the 1938 season:

1. *Regional office fire plan.*—These fires gave us a new conception of what constitutes "the worst probable situation," and the fire-suppression plan will require expansion to take care of another such occurrence, with particular reference to listing increased numbers of:

(a) *Pack and saddle horses.*—I believe it would be desirable for the regional office fire plan to include a list of pack stock available within the region, since it is not possible to obtain locally the number required for a situation such as developed on the Siskiyou last season.

(b) *Airplane facilities for transport purposes.*—Considerable delay was experienced in obtaining airplanes suitable for dropping supplies, and this indicates the need for more careful planning for and listing of this type of transportation.

(c) *S O S units.*—There is an apparent need for more S O S and scouting units. It would probably be best to utilize the regional office personnel for these units, since they are most likely to be available when needed. Also, in order to have men experienced in at least the key positions, suggest utilizing present S O S personnel in key positions and complete with "pick-ups" selected at time of fire from best available source. Experience for key positions is essential.

2. *We need to give more attention to the physical fitness of our fire-line overhead* when selecting and listing men in our fire plans for fire-fighting work. This is particularly true of C. C. C. foremen in charge of C. C. C. crews. Many examples could be cited on the Chetco and Siskiyou Fork fires where disability of overhead, such as weak heart, recent operations, or previous injuries of permanent nature seriously handicapped the organization of suppression crews. But probably more important is the irreparable damage to one's health which may result from the strenuous conditions required by this type of work. It is realized that the requirements of the C. C. C. camp work projects and restrictions limiting selection of C. C. C. foremen often result in a compromise detrimental to fire suppression.

3. *Leadership.*—Whenever choice permits, selection of foremen for fire-fighting work, especially C. C. C. foremen, should be based on their ability to provide inspired leadership, loyal to the management. Again, examples could be cited on the Lone Tree, Chetco, and Siskiyou

Fork fires of C. C. C. boys striking and walking off the job, principally because of poor leadership.

4. *Burning out.*—There is need for emphasis on technique of burning out fire line as work progresses, so as to eliminate the necessity for excessive clearing and width of trench.

5. *Feeding men.*—Provisioning fire fighters on the Chetco fire was not satisfactory, and suggested the need for one agency to handle all rationing. Provisioning fire fighters involves many problems characteristic only of this type of work, such as providing rations best suited to transportation, especially by pack horse and airplane, and the preparation of large quantities of tasty, wholesome food, in many cases over open fires and under adverse sanitary conditions, which requires experienced cooks seldom obtainable from a C. C. C. kitchen. Logically, since the Forest Service is responsible for the control of the fire, it should have complete control of all contributing functions, of which the provision of supplies is one of the most important.

6. *Civilian fire fighters for back country.*—Increased requirements and restrictions, dual administration, and inexperience of Army officers assigned to fire camps make employment of C. C. C. inefficient and infeasible on fires in the back country requiring pack horse or airplane transportation, and a larger number of civilian fire fighters must be depended upon to supply the necessary manpower.

7. *Camp management experience.*—Employment of large numbers of FF men requires experienced fire-line-camp managers trained in all phases of the job. The functioning of Army officers in C. C. C. fire camps has reduced the opportunity for Forest Service employees to gain experience in handling food supplies and kitchen set-up, and our efficiency has been reduced accordingly.

8. *Aerial troubles.*—New problems arose in connection with airplane transportation involving organization to meet the needs for large scale operations: Preparing chutes, packing loads, weighing and listing of contents, transportation of loads to landing fields, loading and preparation of load lists, dropping and retrieving loads, tabulating damages, and assembling chutes for return to landing field.

Dense smoke and fog over the landing and dropping fields proved a serious handicap to airplane transportation, and indicated the need for research to find some dependable device for locating the landing and dropping fields when such conditions prevail. Suggestions advanced so far include use of radio to provide communication between pilot and crew located at dropping field, operating a radio beam by use of a portable storage battery located at the dropping field, and the casting of a light beam from a semispherically shaped mirror located at the field.

9. *Need for "40-man crew."*—In rough and inaccessible areas, there is an apparent need for trained crews of physically supermen capable of sustaining themselves on the fire line for periods of several days with a minimum of S O S. Two methods offer possibilities for securing these crews. They could be hired in advance of the fire season and employed on construction work in the above-mentioned areas; or they could be hired when the need arose, in which case it would be necessary to pay a much higher rate to obtain men meeting the requirements.

Dependable airplane service would materially increase the possibilities of maintaining a larger number of fire fighters on the line continually, by making it possible to deliver cooked food and lunches to them, thus eliminating the fatigue factor of hiking to and from camp.

RETRACTING STRINGS FOR FIRE DISPATCHERS' MAPS

PAUL M. WENTWORTH

*Assistant Forester, Great Smoky Mountains National Park, U. S.
National Park Service*

Good fire control requires perfection in mechanical aids. No one will ever know how many failures are really due to lack of mechanical gadgets that would help the dispatcher to think and act with speed and precision when his bad times come. Here is one ingenious way of providing the needed equipment.

Practically every organization concerned with fire control finds it necessary to construct a map for fire location from cross bearings received from the lookouts. Where more than two or three towers are shown on one map it is desirable to have the strings which are used for the projection of the bearings retractable. Small tape reels that work very well are available for this, but in many instances the cost is too high.

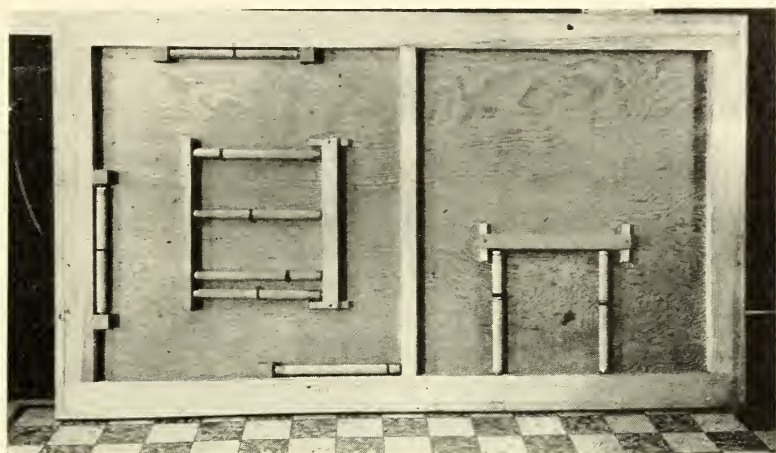
In the preparation of the dispatcher's map for the North Carolina side of the Great Smoky Mountains National Park in which nine towers were involved, the following scheme was used, which proved excellent in operation and reasonable in cost:

Short lengths of $\frac{3}{16}$ -inch diameter bronze rod were taken to a jeweler and drilled through the center with a $\frac{1}{16}$ -inch drill. The ends of this hole were carefully smoothed and rounded and the rod turned down to leave a very small flange on one end. Holes of the proper size were then drilled through the map board at the exact center of each azimuth circle and the bronze bushings pressed into place with the flange on the map side. Exact centering of the mounting hole is absolutely essential to maintain the accuracy of cross bearings and it was found necessary to use a drilling template to do this job correctly.

Good quality curtain rollers were purchased and cut as short as possible. This short length is desirable in order to eliminate as much as possible the bending of the rod when the string is pulled out. The small catches on the end were made inoperative and one roller was mounted on the back of the map board for each tower string. The rollers were located so that the proper side would be directly in line with the hole in the bronze bushing. In mounting the rollers, the regular inside type roller support was used for the end with the round pin, but the flattened end piece was inserted in a closely fitting slot in a wood block. The end of a piece of fishing line of the desired length was attached to the roller with a small tack and the remainder wound on the roller. The loose end was then pushed through the bushing and tied to a small brass ring. In attaching the rollers the support for one end was made removable to facilitate repairs or adjustments.

Using curtain rollers, the length of the strings is limited by the spring to about 6 feet. This should be sufficient in most cases, but where additional length is required it may be obtained by enlarging the size of the roller in one of several ways so as to increase the circumference where the string winds on it.

The dispatcher's map mentioned has been in use for several years and no trouble has as yet developed. Some noticeable wear has occurred where the strings pull through the bushings and it is suggested that anyone using this scheme make the bushings of the hardest material that can be drilled and turned down.



Back of dispatcher's map showing curtain rollers.

The question may arise in the minds of some as to the reason why rings are tied to the strings and not push pins as is the usual custom. There is no doubt that the use of push pins on the strings has several advantages since the strings can be pulled out and the pins pushed in to hold them very rapidly, and it can be done with one hand. Our map is constructed with a soft pine pin strip around the edge and push pins through the rings are used to hold the strings in position. In our case it was felt that rings would serve the purpose better for the following reasons:

1. The strings can be pulled out and fastened as rapidly as the reports could possibly be received.

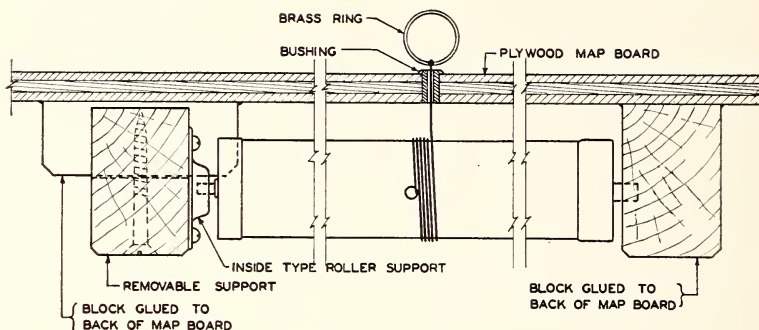
2. When the string for one tower is in use and reports on other smokes are received from the same tower, the pins can be left in place, the rings slipped off, and the string used for projecting the new bearing. By using a separate pin for this new bearing the string can either be left there or returned to its original position very quickly. This procedure can go on indefinitely and it is not unusual during dry weather in this area for one tower to report on as many as five smokes within a very short period. It is seldom that more than one smoke at a time will directly threaten the park, and as soon as other smokes are located the string is returned to that smoke in which the park is most interested.

3. With the pin slanted away from the lookout point the string always lies close to the map. With a push pin on the string it must be pushed "home" before this occurs.

4. Last but not least, one very simple knot eliminates all possibility of the string ever coming loose. Using pushpins the string must first be tied to the pin and then to the glass or metal top if one is to

be sure it will not slip off and possibly disappear behind the map board—a serious situation when things are hot.

For those who are particularly interested in costs, it is pointed out that the largest saving is in materials, and this method will be of most value to those organizations that have regular employees but little



Detail of roller mounting for retracting strings.

money for the purchase of materials. Where spare time or odd moments cannot be utilized for constructing the map the extra value of the time expended in mounting the rollers will partially offset the advantage of their small cost. Ten receding string reels can be installed in several hours, whereas the same number of rollers will require at least a day. Materials will cost about as follows:

Receding string reel (lots of 12 or more)-----	each--	\$1. 50
Curtain rollers, good quality-----	do----	. 25
Turning of bronze bushings-----	do----	. 15
Fishing line, 6 feet-----	-----	. 03

Aerial Delivery of Supplies Being Used by State and Private Organizations.—

On the Smith River fire, partly on the Siuslaw National Forest, the Western Lane County Fire Patrol Association and the State forestry department dropped something over 80 tons of supplies into their Marsh Creek base camp, two ships being in almost daily use from July 10 to July 28, 1938. Although the association and the State department obtained pack stock as fast as possible and immediately constructed necessary pack trails, they would have been unable to make even a good start in supplying necessary food had it not been for the use of airplanes. Our conclusion is, that not only is aerial delivery practical, but may even be essential in many cases where fires occur in inaccessible locations.—L. E. Garwood, fire assistant, Siuslaw National Forest.

What Spot Fires May Do.—The Rocky Creek fire on the Kaniksu National Forest was corralled at 10 a. m. of the first work period. While there was a sufficient number of Scouts looking for spot fires, and nearly 50 percent of the crew was working on spot fires, an undiscovered one about 400 feet from the main fire, got away even though 15 C. C. C.'s and a foreman were working on it 10 minutes after it was discovered.—Gordon T. Cornell, district ranger, Kaniksu National Forest.

WHAT IS "AVERAGE BAD?"

· WILLIAM G. MORRIS

Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service

Preparedness means planning for whatever intensity of action may be required. But the dominant characteristic of fire danger is variability. Then how *can* intelligent planning be done? The author offers one answer to a very puzzling and important fire-control problem.

The term "average bad conditions" has been used with increasing frequency during the last 2 years to describe the fire-danger conditions for which we should lay most of our fire-control plans. The idea of making our principal plans for some level of conditions that is suggested by the term "average bad" seems to have been readily acceptable, but it has been difficult to define or describe just what an "average bad" condition is. How bad is "average bad?"

The term is satisfactory in discussions and in visualizing plans for such facilities as lookouts, firemen, etc., but when a planner actually attempts to determine the number of lookouts necessary under "average bad" visibility conditions, he must know what that means in terms of miles of visibility. Likewise, when he attempts to estimate the size of a suppression squad necessary to handle a fire at a given place under average bad wind velocity he must know what that means in terms of miles per hour. If the plans are to be revised currently, are to be checked, and are to be suitable for comparison with those of other administrative units, "average bad" conditions for which the planning is done must be established by the same yardstick.

It is suggested here that "average bad" be defined as the average of the worst half of the conditions that have occurred during a period of several years. To start with and until more records are accumulated, a 3-year period would serve the purpose.

This average of the worst 50 percent can be easily determined. Suppose we want to determine the average bad wind velocity, for example. Simply tally the wind velocity records in classes of miles per hour. Tabulate the cumulative total number of records or tallies by beginning with the lowest class and working toward the highest. From the cumulative totals pick the class above which lies one-half of the grand total number. Then compute the average of the velocities above this middle class. The accuracy of estimating the midpoint will be increased if narrower class limits are used for tallying the values near what is judged in advance to be the middle value. Very broad classes can, on the other hand, be used for tallying values near the extremes.

"Average bad" relative humidity, rainfall, or fuel moisture would be determined similarly from the average of the values below the midpoint instead of above it.

"Worst probable" is a term which has been used to signify the level of conditions with which emergency plans should be prepared to cope. "Worst probable" wind velocity might be defined as the point above which the highest 2 percent of the wind velocities have occurred in the

past, and likewise "worst probable" relative humidity, fuel moisture, etc., might be defined as the point below which the lowest 2 percent of these values have occurred. This arbitrary 2 percent point is in keeping with L. H. Hornby's conclusion that about 2 percent of the fires occur under conditions which put them beyond human control during the first work period.

This point above which the worst 2 percent of the conditions occur can be determined from the same tally and array of values as those used in determining average bad wind velocity.

TANK-TRUCK STANDARDS

Fire Control Equipment Committee, U. S. Forest Service

During the meeting of the fire control equipment committee in Washington in February, a subcommittee composed of George W. Duncan, Fred W. Funke, William R. Paddock, and Ray C. Iverson discussed tank-truck standards and ways and means of developing them. This article is a brief of the conclusion reached, and will be of real interest to all users of this important item of equipment.

Standard sized trucks for fire suppression use should be the $\frac{3}{4}$ -ton pick-up with four-speed transmission, and the standard $1\frac{1}{2}$ -ton stake body. Larger trucks for this purpose are not needed. Half-ton pick-ups should not be purchased for this purpose, but the $\frac{3}{4}$ -ton trucks in some cases should be built up to the 1-ton class, and the $1\frac{1}{2}$ -ton trucks built up to the 2-ton class.

The tank valves and pump equipment on the trucks should be standard for the region in which they are used. The valves, pump, and power take-off should be the same size and make for the $\frac{3}{4}$ -ton truck as those used on the $1\frac{1}{2}$ -ton truck. Then a region can carry a few spare parts which will fit all its tankers.

A unit of the type of the 6A Hercules pump and power take-off is recognized as the best transmission drive pump yet tried out for small capacity units, and it is therefore recommended that the regions use this type until some other pump is proved definitely better. For high lifts and large volume, however, the Byron-Jackson class of pump is needed, and the 3A Hercules and Panama fanbelt-driven type of pump is used where practically no lift is required, where there is low volume and pressure, and where short hoses are in use.

The subcommittee also recognized that there is need for auxiliary tanks that can be quickly loaded on any truck, the water from such tanks to be transferred to the regular power pumper or the truck equipped with such a pump as the portable type O Pacific Marine, and the water pumped directly on the fire from the auxiliary units.

It was the unanimous opinion of the group that permanent built-up pumper units should be used as much as possible. It was Mr. Funke's belief that the life of such units should be about 10 years, since the mileage traveled by such trucks is very low and most of the wear is in the motor which would no doubt have to be changed at least once in the life of the unit.

SHORT-TERM FOREST WORKERS

H. T. GISBORNE

Northern Rocky Mountain Forest Experiment Station, U. S. Forest Service

When fire-research men take time out from their instruments and statistics to delve into questions of management, the "practical" men to whom management problems have been left may need to step lively to keep ahead. The author suggests some definite answers to the question: "What shall we do to make our practice more responsive to human and social needs?"

In the October 17, 1938, issue of the Service Bulletin, Roy Headley presented, "The plight of the short-term employee in the Forest Service." He stressed the unsocial policy of the Forest Service in giving its fire guards, particularly, not enough employment to permit them to live year in and year out, but just enough to tease some of them back another year and too much to permit them to get W. P. A. jobs the rest of the year.

In the October 1938 issue of Fire Control Notes, Maj. Jno. D. Guthrie flashes another red light in our faces. He stresses the indisputable fact that we are substituting C. C. C.'s for a lot of the good fire cooperators we used to have, and that if the C. C. C.'s should suddenly cease, we would find ourselves in one deep hole. The major also mentioned, all too briefly, the fact that our extended use of the C. C. C.'s to pad our first, second, and third lines of defense "was never intended in the beginning." He refrained from pointing out that this "never intended" use, for regular fire-control positions, deprives many of Headley's 5,000 or 6,000 short-term workers of much employment that we used to be able to give them.

These two dangerous practices of the last few years have combined to produce a third danger—the nonexistence of a supply of trained lookouts and "smokechasers" *adequate* for our known needs during critical fire seasons. The short-term employment now offered to temporary men ordinarily brings back only 60 percent of the trained men needed during years of *average* fire danger. The best 40 percent of those trained each year get jobs elsewhere the next year, if they can. That's a natural characteristic of "best" men. Then instead of using our double-up positions to give training and work to the many additional men that we know we will need in critical years, we do the doubling, some of it anyway, with C. C. C.'s.

Here in region 1 we have a "fire plan" for each forest which shows the number of positions to be manned and the number of men needed according to the degree of danger existing. The supervisors are definitely "for" these plans, with one outstanding and unanimous exception. They ask: "Where and how am I going to step out and get that last 100 to 150 men called for, if and when critical danger occurs, and get men with enough fire experience and training to be worth hiring?" They, the supervisors, will never be able to answer that question under our present policies and finances. The answer to that question is, however, the answer to our problem of adequate fire control in critical years.

We therefore seem to have (1) an unsocial policy toward our short-term workers, (2) too many fire-control eggs in the unpredictable C. C. C. basket, and (3) no provision whatever for an adequate supply of really *trained and competent* lookouts and "smokechasers" for use during critical fire seasons, which are the ones that wreck the good records hung up during all the other years. To a single-track fire researcher, unversed in social economics and interested primarily in assuring adequate fire control at reasonable cost, the last point is the major one. To what avail are all the fine points of silviculture, all the to do about stream flow and erosion control, all the hub-bub about campgrounds and recreational facilities, and all the brain busting over land-planning policies, unless we can first *guarantee* fire control adequate to the requirements of each of these phases of forest-land management?

The situation may be different in other regions, but here in region 1 the guarantee of adequate fire control during critical seasons is still the quicksand on which we are erecting many of our other forestry totem poles.

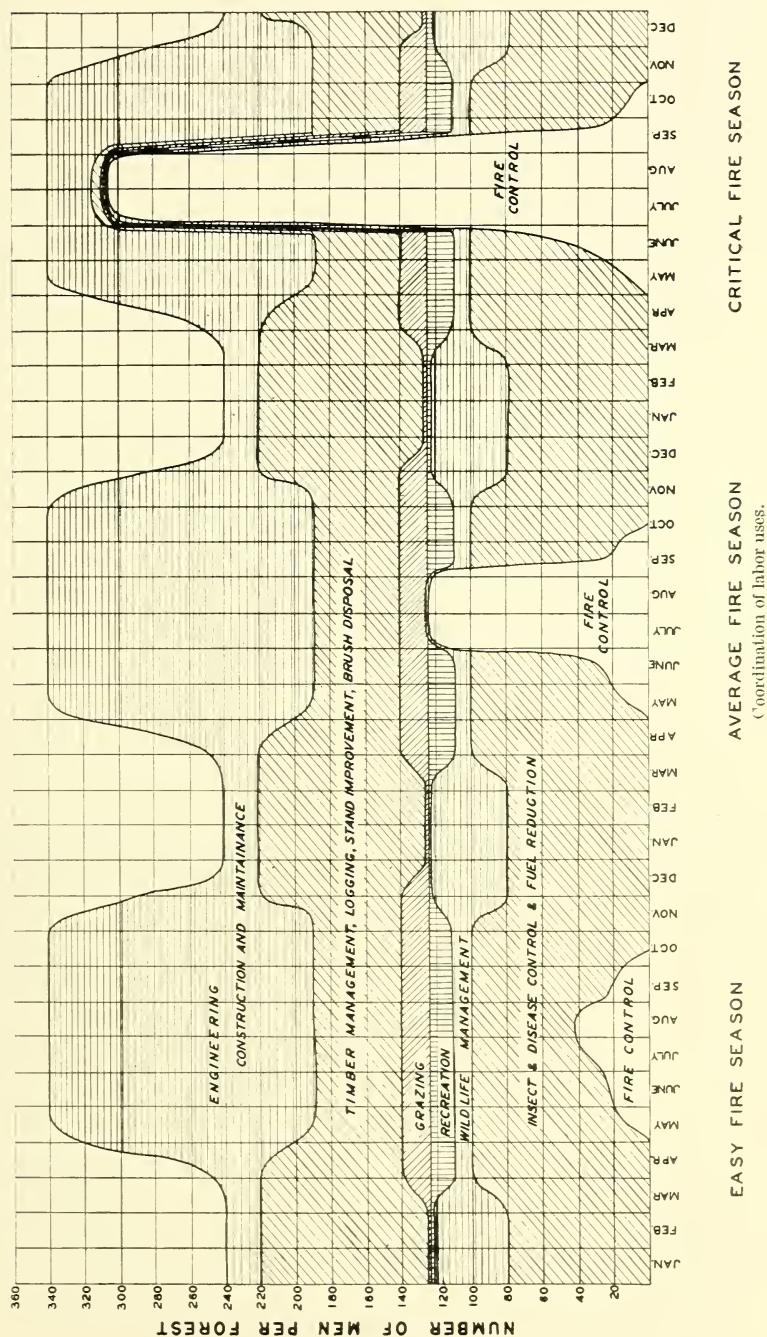
It would seem that some kind of a plan ought to be evolved which would minimize all three of these basic weaknesses. Under a socially minded government someone should have the power and the funds to rectify a social indignity affecting 5,000 or 6,000 worthy citizens; if the C. C. C.'s were not intended and should not be used in fire control except in emergencies, then that policy should be enforced, especially if it will contribute to alleviation of the bad conditions; and if the crux of adequate fire control does now lie solely in the critical season, then that is the bull's-eye at which we ought to aim. The accompanying chart may serve to indicate one possible and partial cure for all three of these present weaknesses.

The chart is intended to illustrate merely the general policy of coordination of labor between divisions of the Forest Service so that (1) adequate fire control may be assured during critical seasons, (2) all divisions may assist—and benefit—in giving longer employment to the forest fringe population, and (3) C. C. C.'s will be used for fire control only during emergencies.

In constructing the chart, the known fire-control needs of a critical season on a typical north Idaho or western Montana forest determined the maximum number of men shown. That is the bull's-eye. This maximum of 340 men includes ranger district temporary overhead, lookouts, "smokechasers," warehouse men, packers, truck drivers, cooks, and crews (held available), but does not include fire fighters. Several thousand fire fighters may be needed occasionally, but that is where the C. C. C.'s come in—during emergencies only. Some 300 *trained* lookouts, "smokechasers," and shock troop crews are needed per million and a half acres, however, whenever danger rises to class 6 and bobs back and forth between 6 and 7, if we are to guarantee adequate fire control. You cannot get *competent* lookouts and smokechasers from the C. C. C.'s. The boys are too young and inexperienced in the woods. In fact, you cannot get them anywhere without providing *training*.

To have trained and competent lookouts, "smokechasers," and crews available whenever the unpredicable critical season smites us, requires reemployment of local woodsmen and forestry-school students

COORDINATION OF LABOR USES



year after year. Can you imagine the Navy storing its battleships in dry docks between wars and then attempting to man them competently by enlistment or even draft after the enemy fleet has set sail for our shores? The Navy applies organization planning first, tactics and strategy second. We might apportion our emphasis similarly.

The other subdivisions or allotments of labor, aside from fire control, shown by the chart, are estimates and approximations at best. The seasonal give and take between divisions is the main idea proffered. It should work best, of course, if the Forest Service had a Division of Forest Protection, rather than merely a subdivision of fire control. Then all forms of insect, disease, and fire control could be coordinated, serviced, and staffed by a year-round operating organization. Every insect and disease-control man would be ready to step into his preassigned fire-control job whenever the danger rating warranted the shift. Every fire-control man would likewise have his out-of-fire-season job on insect and disease control. (No need for quibbling as to what agency will provide the "technical guidance." Merely the labor is at issue here.) Other divisions of the Forest Service, generally, would be tapped for help only during critical seasons, when each man would take his preassigned position as lookout, "smokechaser," or crew man, for which he had been *properly trained*. During average fire seasons the Division of Forest Protection might draw a few men from one or two other divisions, but during easy seasons it would be entirely self-sufficient. The present problem of time and funds for training would be solved automatically by adoption (and financing) of this major principle of coordination of labor.

The last major feature intended to be shown by the chart is the reduction of expense possible during the winter months by recognizing the fact that about one-third of our short-term workers either do not want to work through the winter or have to return to their stump ranches and homes for the duration of rigorous weather. This exodus usually starts, in this region, early in November and is completed a few days before Christmas. Along in April these "hole-up-for-the-winter" specimens begin to feel like working again. With a month's annual leave, however, probably the other two-thirds could and would stay with the job year round.

Staggering of annual leave throughout the winter would help to solve another problem in fire control by eliminating the present costly and sometimes dangerous method of granting leave during temporary lulls in the fire season.

One-Lick Method on the Cedar Camp or Chetco Fire.—One point learned was that the one-lick method of line construction can be used to advantage when only untrained civilian fire fighters are employed. Two occasions came up where we needed considerable line built in short order to stop the fire from burning an increasingly large area. On both occasions crews were organized from men totally unfamiliar with this method of line construction and the line was built in heavy brush at high speed. With more trained foremen and straw bosses, I believe it can become the most efficient method with any type of labor available.—M. M. Nelson, district ranger, Siskiyou National Forest.

HOSE-PIPE LINE FRICTION-LOSS CHART

L. W. LEMBCKE

Wisconsin Conservation Department

Since many thousands of feet of fire hose of various sizes and kinds are used in this country by State and Federal agencies, it is believed that the men using this hose will find helpful a chart showing relative friction loss in different sizes and kinds of hose which will give a basis for calculating the quantity of water that can be conducted through a particular hose when pump characteristics are known.

Chart A shows the approximate characteristics of a pump that meets the requirements of United States Forest Service specification M. S. F.-273. Chart B shows the friction loss in various sizes and kinds of hose and pipe. If in practice the hose is run up grade, 1 pound of pressure must be deducted for each 2.31 feet of vertical rise, in addition to the friction loss, to arrive at the total loss in pressure.

The chart is made up by plotting friction loss in pounds per 100 feet of hose against gallons per minute on log-log graph paper. The advantage of the log-log graph paper is that the scales are so arranged that the resulting graph is a straight line. Since it is known that the graph will be a straight line, fewer test points are necessary to plot the graph and corresponding readings will be more accurate.

The principal loss of head in hose or pipe lines is the result of the friction along the inner wall and among the liquid particles. The conditions which govern the amount of the friction are: (1) The diameter of the hose or pipe; (2) the nature of its inner surface; and (3) the velocity of the liquid. From the many experiments that have been made in addition to our own and from the laws of hydraulics we know that the amount of frictional resistance offered is: (1) Independent of the pressure in the pipe or hose; (2) proportional to the extent of frictional surface; and (3) varies nearly as the square of the velocity. The chart is used as follows:

Example 1.—Suppose it was necessary to lay 4,000 feet of hose to a fire (40- to 100-foot lengths). The difference in elevation is 100 feet. Using 1½-inch linen hose with a pumper capable of pumping against a head of 225 pounds per square inch, how many gallons per minute can be delivered at 25-pound nozzle pressure?

Nozzle pressure.....	Pounds	25
Loss in head due to elevation.....	$\frac{100}{2.31}$	=43
Total.....		68

225 pounds — 68 pounds = 157 pounds that may be used up in friction.

$\frac{157}{40}$ (100-foot lengths of hose)=3.9 pounds that may be lost in each 100 feet.

On the chart the 1½-inch linen hose graph line crosses the 3.9-pound friction-loss line at 21 gallons, which would be the amount of water that could be pumped through the hose with a pump capable of pumping 21 gallons per minute at a 225-pound head. A United States Forest Service Specification M. S. F.-273 pump should operate satisfactorily under these conditions and pumps 20 gallons a minute.

Example 2.—If 1½-inch rubber-lined hose were used under the same conditions, the following quantity of water could be pumped:

	Pounds
Nozzle pressure.....	25
Loss in head due to elevation.....	$\frac{100}{2.31}=43$
Total.....	68
From the chart, at 30 gallons per minute we find a loss of 3.2 pounds per 100 feet. For 40 lengths of hose we have 40 by 3.2.....	¹ 128

Total loss.....	196
-----------------	-----

From the performance curve we can see that an M. S. F.-273 pump will pump 30 gallons at 210-pound total pressure.

Example 3.—If 2-inch rubber-lined hose were used with the same pump, we could expect the following results:

	Pounds
Nozzle pressure.....	25
Loss in head due to 100 foot-elevation.....	$\frac{100}{2.31}=43$
Total.....	68
At 47 gallons we find a friction loss of 2.5 per 100 feet or 2.5 by 40....	100

Total loss of head.....	168
-------------------------	-----

From the pump performance curve it can be seen that the pump will deliver about 47 gallons at 168-pound pressure.

Example 4.—Now take the problem as before but increase the length of our hose line from 4,000 to 6,000 feet, using the same pump.

	Pounds
Nozzle pressure.....	25
Loss in head due to elevation.....	$\frac{100}{2.31}=43$
Total.....	68

225—68=157 pounds that may be used up in friction.

$\frac{157}{60}$ (100-foot lengths of hose) = 2.6-pound pressure that may be lost in each 100-foot length of hose.

On the chart the 1½-inch linen hose graph line crosses the 2.6-pound friction-loss line at 16.7 gallons, the amount of water that could be pumped through the hose with a pump capable of 16.7 gallons at 225-pound pressure. Referring to the pump-performance curve, it will be noted that the pump will not operate under those conditions.

Example 5.—Suppose we try 1½-inch rubber-lined hose under this condition. From the chart we find that the 1½-inch rubber-lined hose will conduct 25 gallons with 2.2-pound loss per 100 feet.

	Pounds
Nozzle pressure.....	25
Loss in head due to elevation.....	$\frac{100}{2.31}=43$
At 25 gallons the friction loss.....	68
2.2 by 60.....	132
Total loss.....	200

Referring to the pump-performance curve, we find that the pump will operate under these conditions.

From examples 4 and 5 it will be seen that under certain conditions a given pump can operate with rubber-lined hose while it cannot with linen hose of the same size, because of its larger friction factor.

¹ Loss.

CHART A

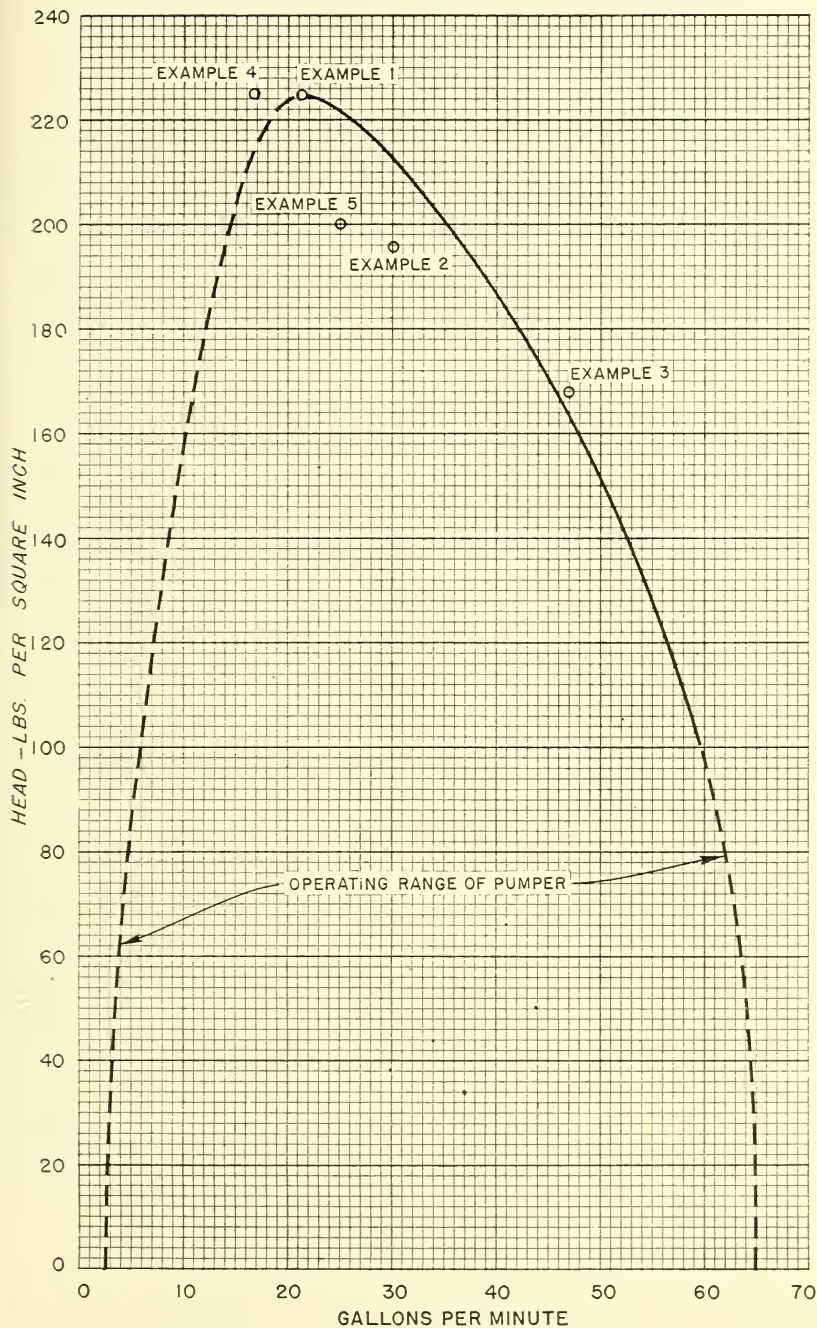


Chart A.—Approximate curve representing minimum performance of a pump meeting the requirements of United States Forest Service Specification MSF-273.

FRICTION LOSS IN HOSE AND PIPE

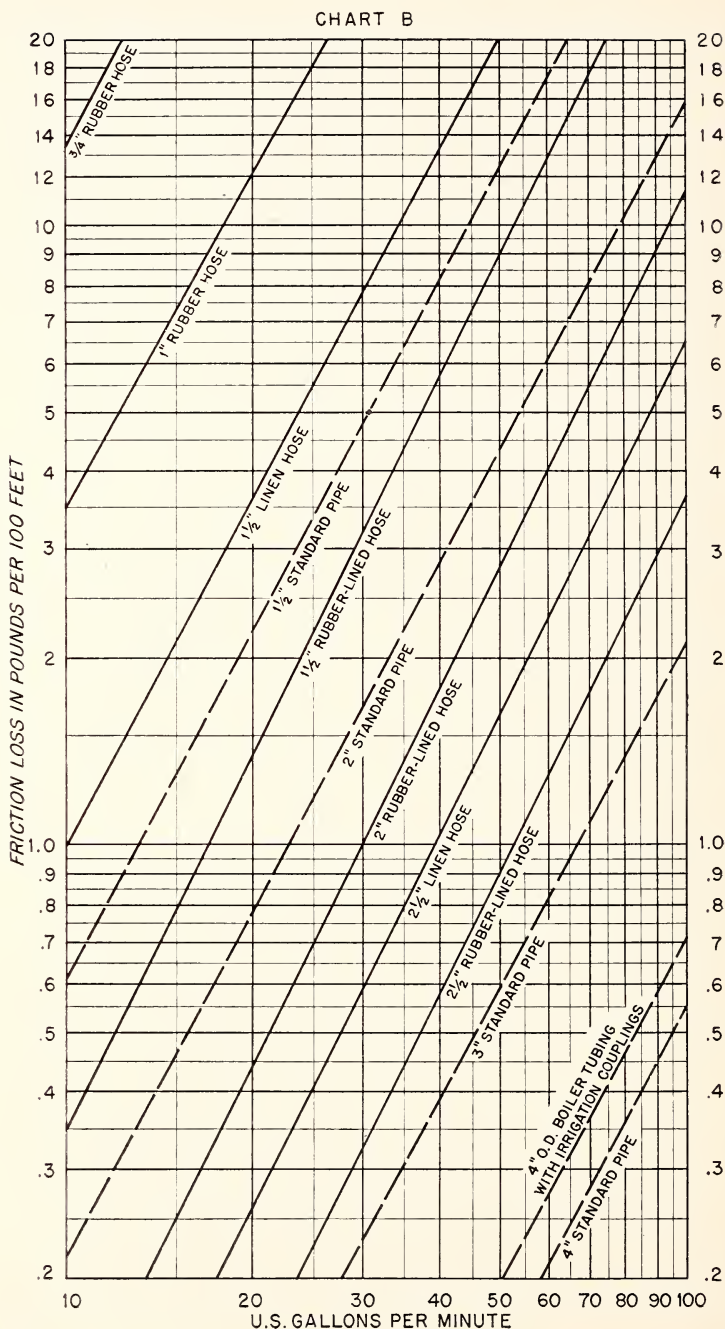


Chart B.—Shows friction loss in iron pipe; linen, and rubber-lined hose. Data from tests and other available information.

HARNEY PORTABLE FIELD LIGHTS

D. P. KIRKHAM

Harney National Forest, U. S. Forest Service

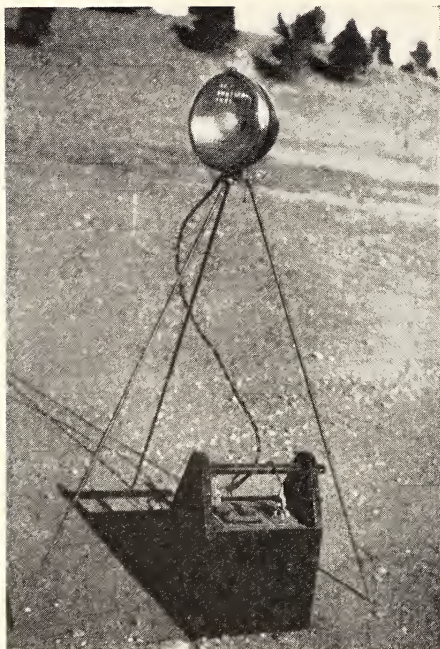
A need for adequate lighting facilities to reduce the accident hazard and permit greater efficiency in fighting fires at night, particularly wherever a considerable part of the fire perimeter to be worked has died down, has long been recognized. Lanterns are poorly adapted to such use, and in many localities in Forest Service region 2, the purchase, maintenance, and servicing of a sufficient supply of individual headlights is not feasible, particularly for the use of C. C. C. crews.

During the past year, Foreman Leo Harbach of C. C. C. Camp F-23, Harney National Forest, has been experimenting with various types of crew lights for night fire fighting. This has resulted in the development of a simple field light, which he believes will reduce the accident hazard of night fire fighting and greatly increase the efficiency of night crews in the Black Hills territory. In addition, he has modified the idea to produce a camp light and a trouble light.

The field light is portable and consists of three pieces—a tripod, a headlight, and a battery, and is designed for use on line construction or mop-up work. The headlight is an old Chevrolet truck headlight. This has been reworked and a standard drop-light socket soldered to the reflector to take the place of the regular light bulb. The socket is equipped with a pull-chain switch, the chain extending through an opening near the bottom where it is readily accessible for switching the light on and off. A standard 6-volt, 25-watt light bulb is used. The headlight is attached to the tripod by using the regular bolt that held it to the truck. The bolt goes through the top ring of the tripod and is fastened by means of wing nuts and so arranged that the light can be focused to either side. The light can be focused up or down by moving the rear tripod leg. The legs of the tripod are 44 inches high, made of $\frac{3}{8}$ -inch round iron with the ends pointed. The center of the tripod is the top washer of an old bramble tent. This was cut down, leaving six prongs extending outward for attaching the legs by means of bolts and wing nuts. The voltage is supplied by a standard 6-volt, 13-plate storage battery. Number 8 twisted, insulated wires are used for connecting the light to the battery with alligator clips and are easily attached and detached from the battery terminals.

This light can be easily moved. The tripod and light can be carried in one hand and the battery in the other, since the battery is in a plywood case with the ends and bottom made of 1-inch lumber. A handle extends the length of the battery and is $4\frac{1}{2}$ inches above its surface. The battery and case weigh 40 pounds and the tripod and light 9 pounds.

By actual test, a battery fully charged will run this light, equipped with a 6-volt, 25-watt bulb, 21 hours. This is sufficient for two nights on the fire line during the short hours of darkness in the usual fire season, although to insure maximum service, it is advisable to change batteries every night. This can be done easily, since we always have trucks with fully charged batteries on all fires.



Harney portable field light developed for night fire fighting by Leo Harbach.

For actual line construction this will give a wide beam of diffused light with no glare for a distance of 300 feet, which is usually sufficient for a crew of 20 to 25 men, with another manning the light. This man directs the light where it is most needed and carries it along as the fire line is constructed. Time saved, better line construction, and the reduction of hazards by having adequate light more than pays for the extra man to operate the light. The use of this light greatly reduces the hazards of falling over cliffs or stepping into mine shafts when directing night crews to the fire line.

The light is also very efficient for mop-up work on the numerous small fires that occur on the Harney Forest. On a fire of 5 acres or smaller, which has largely gone black, it can be set up in the center

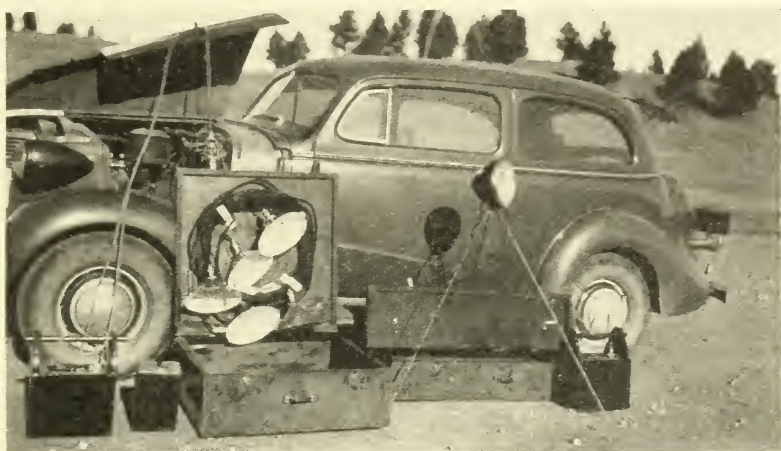
and the light turned as the work progresses. Very satisfactory work can be done up to a distance of 500 to 600 feet from the light. In previous fires it was difficult to pick up small smokes unless there were flames or sparks. With this light, the tiniest smokes can be readily located and extinguished by the back-pack crew immediately, thereby having the fire completely "dead" by daylight.

For transportation in cars or trucks, the headlight and tripod are carried in a plywood case 12 by 8 by 46 inches, which is large enough for two complete outfits, plus extra bulbs. The battery case is just large enough to hold the battery. The sides extend about 3 inches below the top of the battery so it can be easily removed for recharging.

Adequate light for fire camps has long been a cherished dream of all camp bosses, cooks, and fire fighters. It has been a dire necessity but never a reality. It is believed that the camp light developed by Foreman Harbach meets the need. Although this light was designed primarily for use at fire camps, it is ideal for other night work, such as pouring concrete and for innumerable other jobs that must be done with a night crew.

The camp light consists of five sockets equipped with 6-volt, 25-watt bulbs, connected by means of two 100-foot No. 4 insulated copper wires. This heavy wire is used for minimum resistance. A smaller wire was tried but satisfactory results could not be obtained. Standard pull-chain light sockets are used, and are equipped with 10-inch light shades to keep the light on the ground. The lights are spaced 20 feet apart. In order to protect the bulbs two pieces of No. 9 wire are soldered at right angles on the bottom of the shade. No. 14

insulated copper wire is used for drop cords, and is satisfactory if not more than 6 to 8 inches in length. Any 6-volt battery can be used to supply the current. Since pick-ups or trucks are always available at our fire camps, a special battery is not needed. One end of the No. 4 copper is equipped with alligator clips, and the current is obtained by simply connecting one wire to the starter cable and the other to the frame of the car or truck or any bolt that will make a good ground. It does not make any difference which cable is attached



Harney field light, camp light, and trouble light developed by Leo Harbach.

to the starter cable. The far ends of the 100-foot No. 4 cables are insulated, not connected together, and a 100-foot $\frac{3}{8}$ -inch sash-cord is connected to this end for attaching to a tree or pole.

If a fire is in isolated territory and the fire camp set up away from passable roads, the lights and battery can be packed in. A battery fully charged will last 9 hours with a string of five lights, and if the engine is running and the generator set to charge 10 amps, the battery will remain fully charged.

For maximum light it is desirable to have the lights from 10 to 12 feet above the ground. This can easily be done by stringing the wire on trees or cutting suitable poles. The string of 5 lights will give adequate light for any size fire camp up to about 150 men. If desirable, 3 additional lights can be added which will make the string approximately 160 feet long. This can be installed in a semicircle over a fire camp and will give adequate light for both cooks and the crew.

The camp light is housed for transportation in a plywood case 10 by 30 by 30 inches in size. The outfit complete weighs 37 pounds. If the light is to be packed, the case can be made smaller.

Foreman Harbach has also developed a "trouble light" which can be used in case of accidents, for repairing tires, and making emergency repairs. This light consists of 12 feet of twisted insulated No. 14 sash-cord. One end is equipped with a pull-chain lamp socket and a 6-volt, 25-watt bulb, with a wire shield attached to the socket to protect the bulb. At the other end of the cord the wires are equipped

with alligator clips, one of which is clipped to the starter cable and the other to the frame of the car or truck. This usually gives sufficient light for any necessary night work or other emergency. If more light is needed, a 50-watt, 6-volt bulb can be used. In Government trucks which carry C. C. C. enrollees to fires or on other trips light is often needed. The trouble light comes in very handy when a truck arrives at a fire after dark and the fire cache has to be unloaded and tools issued to each enrollee. Without adequate light this is a difficult and dangerous task.

This light can be carried in a plywood case 6 by 6 by 8 inches, which is large enough for an extra bulb, screwdriver, and a pair of pliers. The trouble light, complete with box, weighs 4½ pounds. A battery fully charged will run this light 21 hours.

Heartache and Apology Department.—Does Fire Control Notes have a “heart-ache column?” (It is hereby formally launched.—Ed.) If so, here are the out-pourings of an anguished soul. If not, here they are anyhow.

The April 1939 issue carried a note and illustration of the fine region 1 elapsed time calculator. No complaint thus far—only commendation.

On June 29, 1936, I wrote you a letter submitting an elapsed time calculator which I developed in May 1932 while at the Northern Rocky Mountain Forest Experiment Station. Mr. Godwin replied on July 1, 1936, saying, “This seems quite appropriate for use in the first issue and we will hold it along with other material we are assembling for that purpose.” No complaint thus far—only commendation for you, Godwin, the experiment station, and myself.

But—My calculator was never published. And now, the improved calculator, modified from mine (I hope), has been published. No commendation now, except for region 1’s new calculator—from me, only complaint.

Is Alexander Graham Bell to be forgotten because he did not develop the French desk-dial phone? (Your readers will, I am sure, see the analogy!)—M. A. Huberman. Forest Service Division of Silvics, Washington.

While Mr. Huberman writes with gracious lightness, the editors offer a serious apology for the oversight. They have something of a “bug” for giving proper credit for original creative work.—Ed.

Due-Credit Department.—The Red Cross fire-prevention program appears to be gaining momentum very rapidly, and bids fair to become a Nation-wide plank in that organization’s program. As it gains in importance and becomes better known, it is but natural that the more important forest officers engaging in it will gain credit for their work, and, of course, this is as it should be. However, I hope you will remember that Lloyd Hougland on the Colville is the man who conceived the idea so far as Spokane is concerned, and who first contacted Wallis and sold him the idea. I think Lloyd should have a lot of credit, and so this note.—J. F. Campbell, Forest Service region 6.

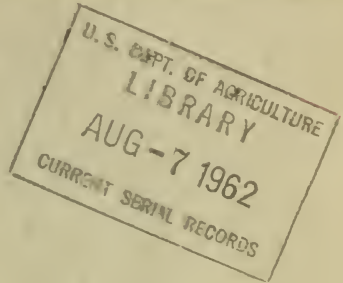
FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technology may flow to and from every worker in the field of forest fire control.

Reserve

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FIRE

CONTROL NOTES



A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

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It is requested that all contributions be submitted in duplicate, typed double space, and that no paragraphs be broken over to the next page.

The title of the article should be typed in capitals at the top of first page, and immediately underneath it should appear the author's name, position, and unit.

If there is any introductory or explanatory information, it should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Text for illustrations should be typed on strip of paper and attached to illustrations. All diagrams should be drawn with the type page proportions in mind, and lettered so as to reduce well. In mailing illustrations, place between cardboards held together with rubber bands. Paper clips should never be used.

India ink line drawings will reproduce properly, but no prints (blackline prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually directly following the first reference to the illustration.

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FIRE CONTROL



FIRE CONTROL NOTES is issued quarterly by the Forest Service of the United States Department of Agriculture, Washington, D. C. The Matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 15 cents a copy or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

The value of this publication will be determined by what Forest Service officers, State forestry workers, and private operators contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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THE USE OF CHEMICALS IN FOREST-FIRE CONTROL

T. R. TRUAX¹

Senior Wood Technologist, Forest Products Laboratory

The Forest Service made its first test of chemicals for fire suppression in 1911 when carbon tetrachloride, a popular material for commercial extinguishers, was found to have no superiority over water in forest fire suppression. The World War led many men to believe that "chemical bombs" could be used effectively on forest fires. In response to this belief, the Chemical Warfare Division of the Army conducted an inquiry. Nothing happened. But the desire to make use of chemistry in fire control persisted. The author reports on the latest and most comprehensive attempt along this line. As a result of a 3-year research project, over 3½ tons of monoammonium phosphate with a 5 percent admixture of sodium dichromate to prevent corrosion of equipment, have been distributed to national forests for the conclusive test—in the hands of fire crews on actual fires as they occur. The current cost of this chemical mixture—17 cents per pound, plus about 2 cents for freight—may prevent its extensive use except in aerial attack, if that venture should prove successful. Foam producing solutions are also in experimental use on national forests, but the special equipment required for their use in man-pack cans is not satisfactory.

Research studies were undertaken in 1936 by the United States Forest Service, with the objective of learning whether chemicals could be used to advantage in forest-fire control and suppression. Studies (1, 5, 8)² of limited extent had been made at various times in the past, but no continuous and comprehensive investigation had ever before been attempted in this country. The use of chemicals as extinguishers for other classes of fires and under other conditions has stimulated the interest of both the public and those responsible for the protection of forest areas from fire in the possibilities of their use in forest-fire suppression. To the chemist, familiar with combustion and its control, the possibility of finding a material that is outstandingly superior to water or to existing chemical extinguishers has not seemed particularly promising. To the fire fighter, who has an understanding of conditions surrounding forest fires, the use of chemicals as an agent in control and suppression has perhaps been more of a hope than an expected development. However, the desire to employ all available ways and means of combating forest fires and to discover, if possible, any new materials of value, led the Forest Service to undertake a study of the possibility of making effective use of chemicals.

¹ Acknowledgment is made to the Division of Fire Control for financing this investigation; to the various forest experiment stations and administrative units of the Forest Service and the Michigan Department of Conservation for cooperation and assistance in making the field tests; and to members of the Forest Products Laboratory, particularly George M. Hunt, Arthur VanKleeck, Howard D. Tyner, and Bruce G. Heebink, who participated actively in the investigation.

² Numbers in parenthesis refer to list of references at the end of this report.

It was recognized at the beginning that forest fires present a situation not at all analogous to the type of fires and the conditions under which chemical extinguishers are now largely employed. The principal characteristics of forest fires as related to the possible use of chemicals are: (a) They occur in the open with an abundant supply of oxygen for combustion and frequently under substantial wind velocities or air drafts. (b) The fuels are almost entirely cellulosic, with a wide range in form, size, and arrangement. Heavy timbers, grasses, leaves and needles, limbs and branches, rotten wood and peat are but a few of the types of materials involved. (c) A large percentage of forest fires occur in more or less inaccessible areas where transportation is difficult, water is often scarce, and the only equipment available during the early stages of attack are hand tools, such as shovels, axes, and back packs for water.

The purpose of this paper is to present the results of the investigation begun at the Forest Products Laboratory in 1936 and continued through 1937 and 1938. The results pertain primarily to the use of chemicals in water solutions, although the results of some tests on chemical foams are included. The data are from laboratory investigations and from field tests on fuels in several forest regions of the country.

Method of Investigation

The investigation involved three steps: (a) Review of the literature and search for promising materials, (b) laboratory tests to compare the effects of various compounds and to study variables in extinguishing fires in wood, and (c) field tests to compare results of the more promising materials on natural fuels of different types and arrangement.

The survey of the literature covered some 440 papers, patents, and other references, and indicated that a large number of materials in one form or another have been proposed or tried as extinguishing agents or retardants to combustion. Most of these may be classified as (a) gases, which alone or in mixtures with air of proper concentrations will not support combustion, for example, carbon dioxide; (b) liquids, which may be a single component, such as carbon tetrachloride, or water solutions of one or more chemicals; (c) solids, such as dry sodium bicarbonate; and (d) foams, most of which are a mixture of water, chemicals, and carbon dioxide gas. Some materials may occur in two or more forms, for example, carbon dioxide which is available as gas, liquid, or solid.

The usefulness of gases as extinguishing agents is generally considered to be limited to fires in inflammable liquids or to other burning materials in confined spaces where the fuel can be covered or surrounded by the necessary concentration of gas to prohibit combustion. This involves maintaining a layer of gas over the fuel until it has cooled below the combustion temperature. For materials burning in the open and in deeply glowing fuels where a considerable accumulation of heat exists, this condition is generally impractical to obtain. For these reasons, gases, which are effective under special situations, do not appear to offer promise as forest-fire extinguishers.

Solids have been suggested primarily because of their smothering effects. This may result from a liberation of combustion-retarding gases or from the air-excluding action of inert materials combined with their mass cooling effect. The bicarbonates, some of which liberate carbon dioxide at fire temperatures, and dusts of heat-resistant compounds illustrate this type of material. The action of finely divided soil (dust) is familiar to most forest-fire fighters.

The blanketing action of foams, which is of value on burning oils, is generally regarded as of less significance on fuels of the type involved in forest fires. While foam-type extinguishers are recognized as of value for fires in wood, paper, textiles, and the like, they are not necessarily considered superior to water or solutions containing large percentages of water (6, 10). However, the increase in volume of foams over the original chemical solutions, as a result of entrapped carbon dioxide, seemed to offer large theoretical advantages and stimulated considerable interest in their possible use in forest-fire suppression.

Based on a consideration of the types of fuels involved, the conditions surrounding forest fires, the extinguishing action and limitations of various chemical agents, and the equipment and problems involved in use, it was decided to confine the investigation primarily to water solutions of chemicals. Water is now used extensively, and it seemed possible that chemical solutions might be used in the same equipment. Some tests were included on foams in order to compare them with the more promising chemical solutions and water, although the use of foams would obviously entail special equipment.

The choice of chemicals for test in water solutions was based in large part upon the work of previous investigators, but a few were included because of theoretical or other considerations. Barrett (1), Mitchell (5), Stickel (8), and others in the Forest Service had gotten some encouraging results with potassium carbonate and calcium chloride a number of years ago. Thomas and Hochwalt (9) had reported marked effects for solutions of potassium and sodium salts in extinguishing gasoline fires. Work at the Forest Products Laboratory had compared the fire retarding action of a large number of chemicals when impregnated into wood (3). Russian investigators (7), in 1932 and subsequent years, had investigated several chemicals to determine their value in forest-fire control. From these various sources and others the list of chemicals for test was prepared.

Laboratory Studies

Laboratory tests were used as a method of getting within a limited time the comparative extinguishing properties of a considerable number of chemicals in water solutions of different concentrations. More than 800 standardized and controlled small-scale, fire-extinction tests were made with different chemical compounds and concentrations of solutions. The usual procedure was to make extinction tests on a standard wood fire with a 25 to 30 percent (by weight) water solution of a given chemical, and, if it showed appreciably higher effectiveness than water and was otherwise promising, additional tests at lower concentrations were made.

The method of test was an adaptation of that used by Folke (2), a Danish investigator, in a study of the factors involved in fire extinction. The standard fuel pile consisted of 18 pieces, 1 by 1 by 6 inches in size, of clear, surfaced, southern pine wood. After conditioning to 6 to 7 percent moisture content, the pieces were selected by density to give a total weight of approximately 990 grams (2.18 pounds) for the 18 pieces. The pieces were arranged in the form of a crib—3 in a layer and 6 layers high on a wire screen attached to the platform of a scale that permitted continuous reading of the weight during test. The wood was ignited by means of a battery of 4 gas flames placed directly beneath the crib for 1 minute. The burning was allowed to progress until 50 percent of the original weight of the crib was lost, at which time extinguishing began. The liquid was applied as a small jet from a glass nozzle at a predetermined and controlled rate.

Data were recorded of the volume of liquid used for flame extinction and for total extinction (including glow), of elapsed time for flame and for total extinction, and of the crib residue remaining after complete extinction. A series of several tests was made with each chemical solution and concentration. Similar tests were made using water as the extinguishing agent, to afford a basis for evaluating the effectiveness of the chemical solutions.

The comparison of the various chemical solutions and water was made at a constant rate of application of solution and under quiet air conditions. Tests were made later on the standard fire, using different rates of application of extinguisher and under varying horizontal wind velocities.

Results of Laboratory Tests

Of the data obtained, the volume of liquid required for extinguishing the fire was considered the most reliable and probably most significant indication of effectiveness. The time required for extinction paralleled rather closely the volume used, but since the application was intermittent during the later stages of extinguishing (suppression of glow) the elapsed time was considered less accurate than volume of liquid used. The amounts of fuel consumed during extinguishing, as determined by the residual weights of cribs, also indicated comparative effectiveness and gave the same general conclusions as did the relative amounts of liquids used. The effectiveness of the chemical solution was expressed, for convenience, as a "superiority factor," determined by dividing the volume of water (as a standard) by the volume of chemical solution used. Values were determined separately for flame extinction and for total extinction, including both flame and glow.

The results obtained with various chemical solutions of about 25 to 30 percent concentration are shown in table 1. The effectiveness, expressed as superiority factors, ranged from less than one (less effective than water) to more than two (twice as effective as water). Examples of chemical solutions that were less effective than water are citric acid, tartaric acid, and ammonium nitrate. Examples of solutions showing two or more times the effectiveness of water for total extinction are phosphoric acid and the ammonium salts of phosphoric acid. For extinction of flame alone, the acetate, bicarbonate, and

carbonate of potassium showed the highest effectiveness of the materials tested. Monoammonium phosphate, which showed little superiority over water for flame extinction in quiet air, showed high superiority for both flame and total extinction in a later series of tests made under substantial wind velocities.

TABLE 1.—*Extinguishing properties of concentrated water solutions of chemicals compared with water*

[Tests made under quiet air conditions, liquid applied at rate of 26 cc. per minute]

Chemical	Concentration of solution by weight	Superiority factor ¹ based on volumes used for—	
		Flame extinction	Total extinction
	<i>Percent</i>		
Acid, citric.....	25	0.90	0.75
Acid, phosphoric.....	26	1.50	2.40
Acid, tartaric.....	25	.75	.60
Aluminum sulphate.....	23	1.00	1.40
Ammonium carbonate.....	28	1.10	1.40
Ammonium chloride.....	28	.95	1.50
Ammonium nitrate.....	25	.80	.80
Ammonium nitrate.....	29	1.10	1.00
Ammonium phosphate, di-.....	26	1.30	2.10
Ammonium phosphate, mono-.....	26	1.20	2.00
Ammonium sulphate.....	26	1.10	1.70
Calcium chloride.....	26	1.10	1.50
Cobaltous chloride.....	25	1.00	1.30
Lithium chloride.....	27	1.25	1.80
Magnesium chloride.....	25	1.20	1.70
Magnesium sulphate.....	30	1.10	1.30
Potassium acetate.....	30	1.75	1.80
Potassium bicarbonate.....	25	1.70	1.55
Potassium carbonate.....	25	1.90	1.70
Potassium chloride.....	25	.90	1.20
Sodium acetate.....	27	1.50	1.60
Sodium chloride.....	25	1.10	1.00
Sodium phosphate, mono-.....	24	1.00	1.50
Sodium silicate.....	22	1.00	1.20
Stannous chloride.....	25	1.10	1.50
Zinc chloride.....	30	1.30	1.70

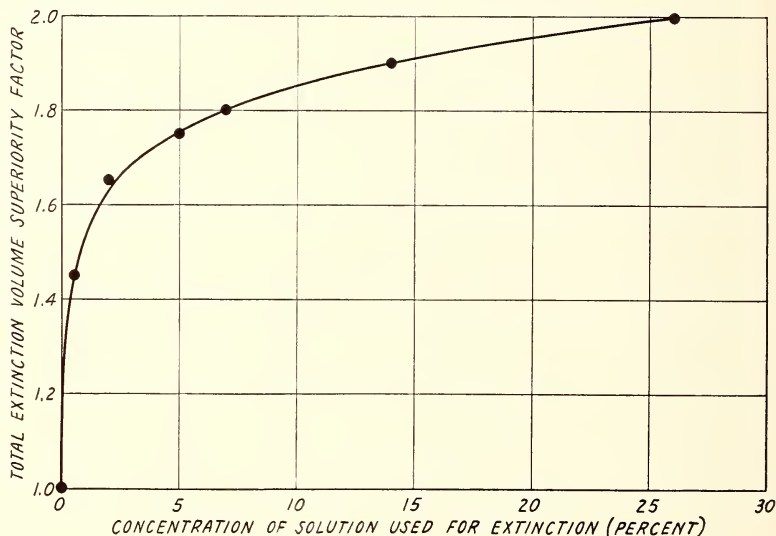
¹ Calculated by dividing the average volume of water by the average volume of chemical solution used in extinguishing similar fires.

Boric acid, hydrochloric acid, oxalic acid, ammonium borate, ammonium oxalate, and sodium sulphate were tested also, but only at substantially lower concentrations of solutions. Of these, only boric acid showed appreciable superiority over water. At 5 percent concentration, which was about the maximum obtainable with boric acid, its effectiveness compared favorably with that of phosphoric acid or of the mono- and dibasic ammonium phosphates at similar concentration. Tests were also made on combinations of two chemicals in the same solution, but the results indicated no advantage over the single chemicals at the same total concentration.

With a number of the more effective chemical compounds, tests were made on solutions of lower concentration to study the relation of concentration to effectiveness. The tests were made under quiet air conditions and at the same rate of application as used in the comparative series on various chemicals. Figure 1 shows the results obtained for monoammonium phosphate, plotted to show the relation between concentration and total extinction effectiveness. It is evident that a large percentage of the superiority of the chemical solution over water is obtained with 1 to 2 percent concentrations and that the

increase in effectiveness is less rapid for concentrations above 2 percent.

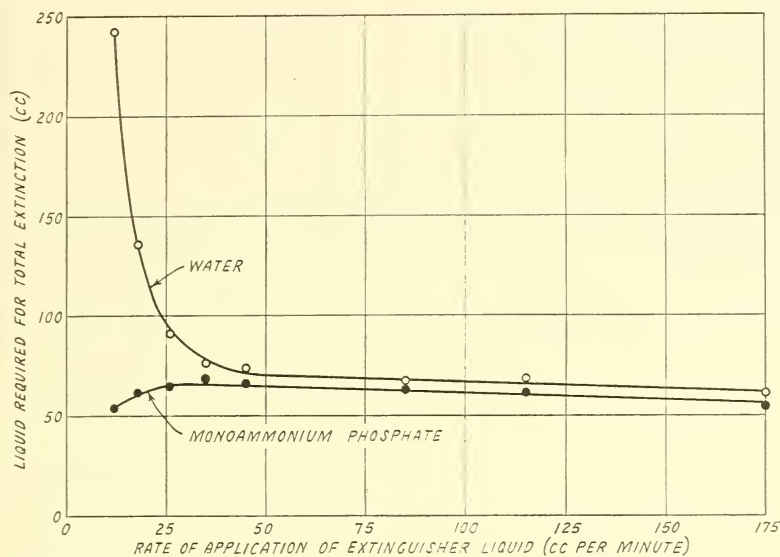
A third series of tests was made to study the effect of varied rates of application of extinguisher. A 10-percent solution of monoammonium phosphate was compared with water on standard fires under quiet air conditions with rates of application of from 12 to 710 cc. per minute. The actual volumes of water and chemical solution required for total extinction, for rates of application within the range of 12 to 175 cc. per minute, are shown graphically in figure 2. The comparison of various chemical solutions shown in table 1 was made at a rate of 26 cc. per minute. At a rate of application of about 40 cc. per minute and above, the advantage of the chemical solution over



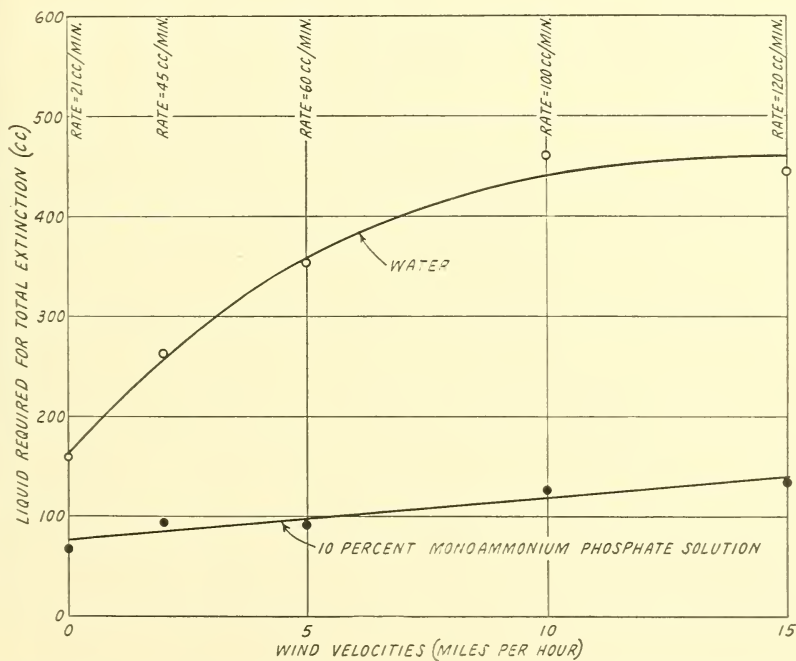
Relation between total extinction volume superiority factors and the concentration of monoammonium phosphate solution.

water is small and fairly constant. With lower rates of application the amount of water required for total extinction increases rapidly, whereas the amount of chemical solution decreases slightly. At the lowest rate of application, more than four times as much water as 10 percent monoammonium phosphate was used for total extinction. At still lower rates it was impossible to extinguish the fire with water before the crib collapsed. This series of tests shows rather clearly that the superiority of a chemical solution over water is not a constant, but is related to the rate of application of extinguisher for a relatively constant size and severity of fire.

It became evident during the course of the investigation, particularly in the field tests, that wind velocity was an important factor in extinguishing and that the relative effectiveness of chemical solutions and water might change when tested under substantial wind conditions. Consequently, late in the course of the study, some laboratory tests were made under constant and controlled horizontal wind velocities. A 10-percent solution of monoammonium phosphate



The variation in volume of 10 percent monoammonium phosphate solution and water required for total extinction, with change in rate of application.



Average amount of water and of 10 percent monoammonium phosphate solution required for total extinction at different wind velocities.

was compared with water on wood crib fires under wind velocities of 0, 2, 5, 10, and 15 miles per hour. With increasing wind velocities, it became necessary to increase the rate of application of liquid in order to extinguish the fire. The rates of application used in one series of tests were selected, after some preliminary work, to obtain approximately the same weights of crib residues (amount of fuel remaining after extinguishing). In the other series of tests a relatively high rate of application was used throughout. The results are shown in table 2 and a part are presented graphically in figure 3, in which the volumes of liquid required for total extinction are plotted against wind velocity.

TABLE 2.—*Effect of wind velocity on fire extinction superiority of 10 percent monoammonium phosphate solution over water*

Number of tests averaged	Wind velocity	Rate of application	Superiority, factors		Crib residue (percent of original crib weight)	
			Flame extinction	Total extinction	Extinguishing agent: water	Extinguishing agent: chemical
	<i>Miles per hour</i>	<i>Cc. per minute</i>			<i>Percent</i>	<i>Percent</i>
5	15	120	4.5	3.3	31	38
5	10	100	4.3	3.6	32	42
5	5	60	3.3	3.7	32	42
5	2	45	2.3	3.1	31	39
5	0	21	1.3	2.1	28	34
5	15	100	5.0	4.0	18	37
5	10	100	4.3	3.6	32	42
-----	0	100	1.0	1.1	47	49

It is at once apparent that the superiority of the monoammonium phosphate solution over water increases with an increase in wind velocity. With velocities of 10 and 15 miles per hour it required some three and one-half to four times as much water as chemical solution to extinguish the fire. Had it been possible to extinguish the fires with water at lower rates of application the superiority of the chemical solution would doubtless have been still larger.

This series of tests indicates that wind velocity has a major effect on the size of superiority factors of chemical solutions over water, and that values obtained for the various chemicals tested in quiet air (table 2) do not apply under appreciable wind velocities. A considerable number of the chemicals tested, particularly those that showed high total (flame and glow) extinction properties, as illustrated by monoammonium phosphate, would be expected to show increased effectiveness with increased wind velocities. Apparently the flame extinction superiority of chemical is related to its glow extinction property under substantial wind velocities. Although flame may be temporarily extinguished, the glowing fuel is quickly fanned into flame again by a substantial wind, unless the chemical exhibits marked glow extinction properties. Since field fires are commonly accompanied by strong air currents, it appears that the superiority for total extinction is of much greater practical significance for most field fires than superiority in flame extinction alone.

During the progress of the investigations it was learned that Metz (4) working in Germany and using similar laboratory test procedure, had tested a group of 10 chemicals that were included in the Forest

Products Laboratory tests. A comparison of the results of the two independent investigations shows a similar order of effectiveness for the 10 chemicals. Metz also found ammonium phosphate the most effective of the several materials tried.

Field Tests

The laboratory tests gave valuable indications of the comparative effectiveness of a considerable number of chemicals under rather carefully controlled conditions. In the laboratory it was possible to vary the rate of application to the size and severity of the standard fire, to approach the minimum rate and quantity required for extinction without danger of the fire getting out of control, and to apply all liquids to fires similarly and with little waste; objectives which could not be attained so well under field conditions.

The laboratory tests, however, were confined to a single type, size, and arrangement of fuel of approximately uniform moisture content. Consequently, it was considered desirable to check the laboratory results for a few of the most promising chemicals on the more important forest fuels and as much as possible in their natural arrangement and condition, by different methods of application.

A total of more than 2,000 field tests were made on grass and palmetto-grass fuels of the South; hardwood leaf litter of the Appalachian region; slashings of the Lake States, Appalachian, and Pacific Northwest; logs and branches, bracken, and rotten wood of the Pacific Northwest; and pine duff and brush of California. In each of these various regions, the local Forest Service experiment stations and administrative units cooperated in making the field tests.

Where it was feasible and practicable, the fires were set in the fuels in their natural arrangement and condition. This was true for all tests in grass, palmetto-grass, hardwood leaf litter, pine duff, and brush. Slashings, logs and branches, bracken, and rotten wood were artificially arranged, however, either because of their nonuniform natural distribution or on account of the danger connected with burning them in their natural arrangement under the conditions prevailing at the time of test.

Chemicals for field tests were selected on the basis of their showing in the laboratory tests. Phosphoric acid and its monoammonium and diammonium salts had shown the highest total extinction effectiveness through a wide range of concentration. Of this group the monoammonium phosphate was used on all fuels tested in the field. Ammonium sulphate was included in the field tests on a number of fuels because of its moderate effectiveness and low cost. Either the bicarbonate or the carbonate of potassium, both of which had shown high flame extinction properties in the laboratory, was used on those fuels in which the flaming type of combustion seemed to predominate. In the later series of tests some work was done with foams. Field tests on one or more fuels were also made with calcium chloride, boric acid, phosphoric acid, and sodium acetate.

The procedure used in the field tests was modified from time to time as the work progressed, experience was gained, and additional equipment became available. For most of the tests an experimental unit, consisting essentially of a small air compressor, pressure tanks for liquids, hose and nozzles, was employed. A number of types of nozzles

were used, but one adjustable over a wide range in rate of flow of liquid was employed extensively in the field tests. In some tests back packs were used, and in a few tests power pump equipment was employed. These were all included in a portable field laboratory containing a variety of equipment for preparing and applying solutions and foams and taking the measurements and data required.

In the early field tests, alternate fires were extinguished with chemical solution and water, respectively. Considerable difficulty was experienced, however, in obtaining successive fires of equal severity, because of wind conditions at the time of test and other factors. A method of making two tests simultaneously—one with chemical solution and one with water—was finally evolved in the later experiments. This method overcame the irregularity due to wind. The two fires started at the same time were extinguished simultaneously by two operators with similar equipment, one using water and the other chemical solution. For succeeding tests, the operators alternated water and chemical solution regularly, each extinguishing the same number of fires with each liquid in a series of tests.

The data taken varied somewhat from one series of tests to the next. However, in all tests the quantities of liquids used for knocking-down the flame and mopping-up the glow, and the elapsed time occurring during extinction were recorded. In the naturally arranged fuels, measurements were commonly made of the length of the extinguished line or the areas burned. Readings were also made of weather conditions, including temperature, relative humidity, and wind velocity and direction. In some cases, moisture contents of fuels were determined.

Considerable care was exercised to have fires of comparable size and severity for extinguishing with water and chemical solution. Areas of naturally arranged fuels were selected to obtain as much uniformity as possible. Artificially piled fuels were selected to get uniform kinds and quantities of material and to have them arranged in like manner for corresponding water and chemicals fires. With all the care used, however, it was felt that large differences were common in the test fires, particularly in the naturally arranged fuels. Furthermore, no constant relation between rate of application of liquid and size of successive fires could be attained, and the wind velocity and direction fluctuated considerably, both during a single test and from one fire to the next. These variations caused wide fluctuations in the results in successive tests and series of tests that were intended to be alike.

In table 3 are shown the average results obtained in the numerous field tests on different fuels with several chemical solutions and foams. The values, shown as superiority factors, are similar to those used to express the results of the laboratory tests, and represent the ratios of quantities of water and chemical solution required for total extinction of test fires. For example, a factor of 1.5 indicates that 50 percent more water was used than chemical solution in extinguishing the test fires. A range of values, as 1.2 to 1.6, indicates that the results varied as shown in different series of tests made at different times and under somewhat different conditions.

While there are definite limitations to the data because of non-uniform test conditions, certain important indications are neverthe-

less evident. Chemical solutions and foams show different results on different fuels. The flame extinguishing types of chemicals, such as the bicarbonate and carbonate of potassium, made their best showing on the flashy types of fuels, like standing grass and loose hardwood leaves, and were of little or no benefit on the glowing types of fuels, like slashings and closely compacted pine duff. On the other hand, the pronounced glow-retardant chemicals, of which monoammonium phosphate was selected as representative, were most effective on the glowing types or combinations of glowing and flashy types of fuels, such as fresh pine slashings, but showed substantially increased effectiveness over water on all fuels tried, except rotten wood. Foams were of most value on logs and branches and rotten wood, where the burning surfaces could be coated with a continuous layer of the foam. In green slashings, bracken, and similar materials, where the fuel is thick and matted, the foam cannot be applied readily to the burning surfaces and has little or no advantage over water. In general, the best results with foam were obtained when the combined foam-forming and fire-retardant chemical solutions were expelled as a liquid or as a partially expanded foam. Considering the range of fuels and concentrations of solutions tested, monoammonium phosphate was the most effective material tested. Furthermore, it is moderate in cost, appears to be otherwise suitable, and is the most widely applicable.

TABLE 3.—Comparative effectiveness of chemical solutions and foams in direct extinction field tests

Extinguisher		Superiority factors ¹ based on volumes of water and chemical solutions used for total extinction on—								
Chemical	Concentration	Grass	Palm-to-grass	Hardwood leaves	Pine duff	Coniferous slashings	Logs and branches	Bracken	Brush	Rotten wood
	<i>Pct.</i>									
Ammonium phosphate, mono-	2.5	1.2	-----	1.3	-----	1.2-1.6	-----	-----	-----	-----
	5.0	1.3-1.5	1.6	1.4	-----	1.4-2.1	-----	-----	-----	-----
	7.5	1.4	-----	-----	-----	1.5	-----	-----	-----	-----
Ammonium sulphate-----	10.0	1.5	-----	1.5	1.8	1.5-2.4	1.3-1.5	1.4	1.5	1.1
	5.0	1.3	-----	1.2	-----	1.3	-----	-----	-----	-----
	10.0	1.1	1.2	1.3	1.3	1.4-1.6	-----	-----	-----	-----
Boric acid-----	15.0	-----	-----	-----	-----	1.5	-----	-----	-----	-----
	2.5	-----	-----	-----	-----	1.2	-----	-----	-----	-----
	4.0	-----	-----	-----	-----	1.4	-----	-----	-----	-----
Calcium chloride-----	10.0	-----	-----	1.3	-----	1.3	-----	-----	-----	-----
	20.0	-----	-----	-----	-----	1.8	-----	-----	-----	-----
Phosphoric acid-----	5.0	1.4	-----	-----	-----	-----	-----	-----	-----	-----
Potassium bicarbonate-----	5.0	1.2	-----	-----	.6	-----	-----	-----	-----	-----
Potassium carbonate-----	10.0	1.4	-----	-----	-----	-----	-----	-----	-----	-----
	5.0	1.2	1.3	1.3	-----	1.0	-----	-----	-----	-----
	10.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sodium acetate-----	5.0	1.2	-----	-----	-----	-----	-----	-----	-----	-----
Foam not loaded ² expelled as a liquid-----	9.0	-----	-----	-----	-----	-----	1.2	-----	-----	-----
Foam loaded ² expelled fully expanded-----	16.4	-----	-----	-----	.5-.8	.7	.7	-----	-----	-----
Foam loaded ² expelled as a liquid-----	16.4	-----	-----	-----	1.1	1.1	1.6	1.1	1.4	1.6
Foam, Kempak (loaded)-----	18.8	-----	-----	-----	1.2-1.5	1.3	1.3	-----	-----	-----

¹ Superiority factors calculated by dividing volume of water by volume of chemical solution used in totally extinguishing similar fires. Different procedures were employed in conducting tests on the different fuels so that the values shown are not entirely comparable in all cases.

² "Not loaded" foam contained only foam-forming chemicals; "loaded" foams contained approximately equal amounts of foam-forming chemicals and fire-retardant chemicals.

Pretreatment Tests

Field tests were also made in which the fuels were pretreated in advance of an oncoming fire. These tests were made in several ways to determine the value of chemicals in holding a line from which to backfire, or as a barrier or firebreak. Of the chemicals tried, phosphoric acid and its ammonium salts were found most effective. In pretreated strips of grass and pine duff, in which the water was allowed to evaporate before test, moderately severe fires were completely stopped by the fire-retardant chemical. Lines, freshly treated with monoammonium phosphate solution and from which back fires were set, were much more easily held than lines treated with water alone.

Summary

The results of both laboratory and field tests show that the extinguishing capacity of water can be increased or reinforced materially by the addition of certain chemicals, the increase depending upon both the kind of chemical and its concentration in the solution.

The superiority of a given chemical and concentration of solution over water is not a constant, but varies with a number of factors, of which (a) the rate of application in relation to the size and severity of the fire, (b) the wind velocity, and (c) the kind and arrangement of fuel are important. Dependent upon the conditions prevailing, the amount of chemical solution required may range from approximately the same as water to only a small part of the amount of water required to extinguish a fire.

Of the various chemicals and foams tested, monoammonium phosphate solution appears thus far to be the most practical and promising, all things considered, for most types of forest fuels.

Where an abundant supply of water is available and can be used, chemicals are not considered to have any worthwhile application. Where water is scarce or difficult to get to the fire, or where the available equipment is scarcely adequate to cope with the fire, the intelligent use of chemicals can yield important advantages. In border-line cases, chemical solution may control or hold a fire where water fails, and chemicals may, in such cases, make all the difference between success and failure in an attack upon a forest fire. The use of chemicals appears most important in the early or initial stages of attack, through the use of back packs and tankers, and they probably have little if any application on large going fires, unless for use when back firing.

It is realized that only a few of the many chemical materials and methods of application have been investigated and that further research in the field may yield valuable results. However, miraculous results with chemicals are not to be expected nor are chemicals equally effective under all forest fire conditions. Furthermore, to utilize present known fire-retarding and extinguishing chemicals efficiently, further studies are needed to develop or adapt apparatus and methods for their application. It is believed, however, that the work thus far points the way to a new and useful weapon for the forest-fire fighter that will ultimately assist him in his never-ending fight against fire.

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Quick Get-Aways.—At F-32, C. C. C. camp at Mayhill on the Lincoln National Forest recently a group was walking back to the camp office when without warning Superintendent Ray Craig turned loose a series of shrill blasts on his whistle. A dozen enrollees came pouring out of the camp shops, from off a camp trailer under construction nearby, from around nearby buildings, some hatless, others with shirt-tails flapping, but all with one objective—to get up the steps and into the fire truck. In less than 30 seconds by the watch the driver was in the seat, the motor turning over, and in just 45 seconds Project Assistant Ray Stoddard had latched up the tail gate, grabbed the open door of the cab and the truck rolled out, with its trained fire crew, its full equipment of tools and rations for 20 men, and its red flags at all four corners warning road traffic that the Mayhill fire truck was on its way to keep another Sacramento Mountain fire in class A. The next morning another demonstration, this time a real fire up the Penasco, saw the big Dodge stake body truck hit the camp exit in about 55 seconds. Said the regional office visitor, "Huh, I'd have been a sucker to have bet even a hat band against that outfit on as little as a 1-minute getaway."—Region 3 Daily Bulletin.

RANDOM NEWS NOTES FROM THE FOREST SERVICE RADIO LABORATORY

Contacts with forest officers generally indicate that even those within the region where the Radio Laboratory is located have little idea of the proposed and current work and progress of this Service-wide project. It is planned, therefore, to include in each issue of Fire Control Notes a news letter from the Radio Laboratory, as a means of distributing information of value to users of radio. It should also prove useful in communication planning and in anticipating the application of new designs and improvements.

Automatic Ultra High Frequency Relaying

It is now common knowledge among Forest Service radio users that transmission by ultra high frequency radio (represented by the types A, S, SV, T, and U) is largely limited by topographic barriers. The radio-minded individual, when standing on top of a mountain or other prominence, will usually visualize the tremendous communication possibilities from such a point with even the lowest powered type of ultra high frequency radio transmitter. For general communication purposes it is seldom possible to take advantage of these ideal topographic conditions. Over four years ago the Radio Laboratory decided that something should be done to permit the use of these ideal locations even when not regularly occupied by lookouts or firemen.

The best possibility of making use of these ideal topographic spots would be to equip them with some form of automatic relaying device which would permit picking up messages from portable stations in the field and retransmitting the message to some distant terminal station in sight of the relay point. Such an arrangement would add tremendously to the possibility of applying ultra high frequency equipment to general communication needs.

Because of the complications involved and the relatively heavy battery drains necessary to operate such an automatic relay system, the idea was not actively investigated until early in 1939. Commercial systems employing the automatic relay feature have been in operation for several years. All of these rely upon commercial power, however, and they are so complicated and their mode of operation is such that they are entirely unsuited to Forest Service use.

Since practically all points which are best suited for the establishment of an automatic relay station would be without commercial power, one of the prime requisites of such a system for field use is reduction of dry battery consumption to an absolute minimum. Recent developments in the field of commercial vacuum tubes have permitted exceptionally large savings along this line, and the first automatic unit is now under test at the Radio Laboratory. Naturally many of the solutions of problems encountered in considering other ultra high frequency problems have been applied to this test unit with the result that the automatic portion of the device is much simpler than might be expected. Several improvements must yet be made before the system will operate with a high degree of reliability, however, and it is not expected that the automatic relay will be ready for release to the field for at least 1 year.

The present type S radiophones cannot be satisfactorily used to work into an automatic relay system, because, in order to talk through the relay station it is, of course, necessary to transmit on the fre-

quency to which the relay receiver is tuned. It has been generally agreed by field technicians that the type S radiophone should be revised in several minor points, and in making these revisions some method of tuning the transmitter will be provided to permit working into the proposed automatic system as well as to simplify the method now necessary in calling the new type T model D radiophone.

For those interested in the technicalities of the proposed relay device, a brief discussion of the functioning of the unit now undergoing test is given.

The transmitter and receiver proper of the test unit are fundamentally duplicates of those portions of the new type T model D radiophone. Each part, however, has been built as a separate unit to facilitate experimental alterations. The local oscillator of the superheterodyne receiver has been crystal controlled on the standby frequency. The automatic control device is mounted on a third unit and consists of an open chassis about 6 by 8 by 2 inches, which carries three tubes and five relays.

In order to conserve batteries to the utmost, the receiver does not operate continuously, but is turned on for 5 seconds out of each half minute by means of a weight driven clock. If a carrier of 6 microvolts or greater is present on the receiver standby frequency during the 5-second "on" period, the receiver automatically locks into continuous operation and the relay transmitter comes on the air retransmitting any signal which may be coming into the receiver.

In order that the entire circuit shall not be interrupted during the switchover time between terminal stations, when operating simplex, a time delay of 10 seconds has been provided; i. e., the relay station remains in operation for 10 seconds after the incoming signal has been discontinued. This arrangement allows adequate time for each terminal station to come on the air and hold the relay system in operation without waiting for the receiver to recycle each half minute.

The total battery drain during each 5-second period is 200 ma. at 3 volts, 50 ma. at 1.5 volts, and 18 ma. at 180 volts. Without an incoming signal the relay station consumes the above battery power for a total time of only 4 hours out of every 24.

Unless the relay circuit is required to handle an exceptionally large amount of traffic, it is estimated that the device should operate for a period of from 2 to 3 months without attention or replacement of batteries.

Current Projects—Radio Laboratory

Design of mobile ultra high frequency receiver.—A thorough investigation of commercial receivers for mobile service in this frequency range has failed to disclose a satisfactory unit. The principal problems of this project are the production of a receiver having a tuning range of from 31.5 to 39 megacycles, yet one which is not critical of adjustment over this relatively wide range; the reduction of ignition interference below an objectionable level both from the car in which the receiver is mounted and from other vehicles on the road; the development of a receiver which will permit reception of equipment such as the type S radiophone (standard commercial superheterodyne receivers cannot be used to receive the type S because of frequency modulation of the

transmitter); and the creation of a mechanical design which will retain adjustment of all circuits when the receiver is subjected to severe road vibration.

Design of a substitute for the present type U radiophone.—A greater number of AC operated ultra high frequency radiophones are needed in the field, but because of the relatively high cost of the present type U the purchase of this unit can seldom be justified. The new type U will be similar in appearance to the newest type M and will incorporate a special receiver based on the design of the mobile receiver referred to above. The receiver will be equipped with an automatic calling device, which will eliminate the need of a noisy loudspeaker in constant operation for stand-by.

Preparation of data on five questions of the CCIR Stockholm meeting 1940.—This project involves making numerous technical performance measurements on Forest Service type radiophones. Such data are being submitted by the Department of Agriculture to the United States delegation to the International meeting at Stockholm in 1940. This material, together with that accumulated from other agencies, is used in the basic consideration of radio frequency assignments and performance standards throughout the world.

Design of a metal detecting device for use on saw timber.—The NETSA in New England has a serious problem in milling timber in which are embedded numerous metal objects which have destroyed saws and endangered the lives of sawyers and other head rig workers. The laboratory is investigating the possibility of producing a suitable detector to locate such embedded metal.

Projects for Early Attention—Radio Laboratory

Redesign type S radiophone.—Field technicians have generally agreed that the type S radiophone should be redesigned in several minor points. In addition to several technical alterations, it is proposed to repackage the type S to permit easier and more convenient handling in the field. The new type S will also incorporate some form of transmitter frequency control or monitoring which will permit setting the radiophone on some predetermined frequency. This latter feature is essential for operation into such equipment as the proposed automatic relay and will expedite calls to the new type T. Such a frequency marker device will also be useful in establishing contact with other type S or SV sets.

Antenna and transmission line investigation for UHF.—This is a continuing project, and any improvements in this part of a radio system can be considered equivalent to increasing the power of a transmitter or improving the sensitivity of a receiver. Special low angle arrays of rugged and simple construction will be one of the important considerations investigated.

Honorable Mention Department.—The absence of the Clark National Forest in the list of forests having fires over 300 acres in 1938 was immediately noticed in Washington. In 1936 this forest had 15 fires over 500 acres burning a total of 18,350. In 1937 there were 8 fires over 300 acres burning 4,975 acres. In 1938 not one single fire over 300 acres!

BI-STATE BODY PLANS CAMPAIGN TO REDUCE FOREST-FIRE LOSSES

Woods and mill workers have not been without some appreciation of what forest protection means to them. In many cases they have been more conscious of their stake in forest-fire control and sustained yield than were timberland owners. But organizations of woods and mill workers have seldom given aggressive support to the movement to preserve and renew the raw material on which the security of their members depends. The following clipping from the Union Register, a labor paper of Seattle, sent in by Assistant Regional Forester John C. Kuhns, may therefore have a far reaching significance. It is hard to imagine a more potent force for fire prevention than a great body of organized workers fully conscious of how much forest protection means to their class and determined that carelessness and neglect shall not jeopardize the forest on which their future security depends.

Reforestation and perpetuation of the lumber industry have become in recent years one of the major concerns of the Lumber and Sawmill Workers Union. The men in the mills and woods are becoming increasingly cognizant of need for building not only for the present but also for the future.

Fire has always been the greatest threat to perpetuation of our vast timber resources. Unless fire is curbed, all the efforts to establish sustained yield, selective logging, strip logging, or reforestation are nullified. Forest fires must be held to a minimum if Washington and Oregon are to escape the fate of Michigan and the Lake States which have become barren scrub-covered areas instead of heavily timbered, lumber producing States.

The Oregon-Washington Council of Lumber and Sawmill Workers is taking the initiative in working out a program to stamp out the terrific annual toll due to forest fires. Through the Union Register, through posters, and windshield stickers, the bi-State body is going to impress on the public the necessity of reducing the number of forest fires.

The campaign will be carried on all summer. Lumber workers will be urged to help educate the general public in the need for more care in the woods.

Tangible results are expected to be forthcoming this summer, although the campaign is laid out on a long term basis. Over a period of years, the efforts of the Oregon-Washington Council will undoubtedly do much to help reduce the huge annual losses due to carelessness in the woods.

Boy Scouts as Carriers of Fire Prevention.—Mr. Hugh Fleming, Jr., now with the New England Forest Emergency organization, writes from Boston that 70,000 Boy Scouts will each spend a week in camp during the summer. Every Sunday morning when a group is being sent home, a short talk on fire prevention is given by the Scout Master and two or more Flag posters are given each boy—one for himself, and one or more to put up in his home town where he thinks it will do the most good. The Boy Scout organization is divided into regions similar to Forest Service regions, and anyone interested in promoting a similar movement can get in touch with the regional officials of the Boy Scouts by inquiring from the nearest Boy Scout Master.

SEEN-AREA MAPPING—AN IMPROVED TECHNIQUE

KARL E. MOESSNER

*Junior Forester, Upper Michigan National Forest, Region 9, U. S.
Forest Service*

A technique of seen-area¹ mapping, making use of a cover-type map, the Osborne fire finder or a vertical angle measuring alidade, binoculars, and an elevation—unseen-space scale, has been tried out on the Upper Michigan National Forest and found to produce astonishingly accurate and consistent results.

On this forest a lack of contour maps and a semiflat topography makes profile plotting, whether in the office or in the field, unfeasible. Through necessity, sketching from the tower is the only method used, all work heretofore being done on 1/2-inch=1 mile scale base maps.



View northwest from Tie Hill Tower, Upper Michigan National Forest. The hills in the immediate foreground are 250 feet above the lakes, those in the background nearly as high. Note the landmarks, cover types, and lakes.

Past experience indicates that these maps lack detail necessary in seen-area mapping. Their use has produced annually a crop of sketches so optimistic as to be valueless in detection planning.

Since admitting the weaknesses of our detection system is the first step in correcting its faults, the present technique is designed to map as unseen all areas not *surely* seen. At the same time, no attempt is made in the field to speculate on the relative depth of the unseen

¹ Seen area, throughout this article, means any portion of a 10-mile circle visible to the lookout and may consist of treetops, low shrubs, or ground cover. Any area hidden from the lookout, by being below his line of sight, regardless of how far, is technically unseen.

areas, since without contour maps this would degenerate into pure guesswork. Rather, the mapper shows as nearly as possible what he sees, not what he thinks, in order that the planner may *start* with facts.

Four things have been found necessary to good seen-area mapping:

1. A detailed map giving the accurate² location of a large number of landmarks easily recognized from a fire tower. Topographic symbols, or some indication of topography, are vitally necessary.

2. An instrument, either the Osborne fire finder or an alidade, to enable the observer to sketch the width of the unseen areas, and measure vertical angles.

3. Binoculars, to aid the observer in noting and locating ridges or other masks³ and in recognizing landmarks.

4. A method for determining the length of the unseen area, which will work in semiflat topography and which does not require contour maps.

On Upper Michigan the forest inventory township plats have proved the most suitable map for this work. These plats indicate all cover types over 2½ acres, carry base from aerial photographs, road and lake traverses, and, in addition, show many hills, ridges, and other topographical features.

Normally, these maps are on a scale of 4 inches=1 mile, but for this purpose, photostatic blue-line prints, on a scale of 1 inch=1 mile, have been obtained. These prints are mounted on cloth to form a mosaic for each tower or point mapped. In actual practice the mosaic is trimmed to a circle with a 10-mile radius and temporarily mounted on the fire finder by means of Scotch tape.

This preference for timber-type maps as a base in seen-area mapping should perhaps be further explained.

Since the topography in this part of the country is relatively flat, in many parts of the forest a stand of timber 70 feet high may prove as much of a mask as a hill or may double the height of an existing hill. It is, therefore, imperative to be able to locate on the map all stands of mature timber.

Timber types on this forest consist of a number of coniferous and deciduous associations which change character at a slight variation in soil or moisture, but which appear consistently in the same topographical locations. While this natural ecology may be somewhat altered by cutting and fire, it can be accepted that a species characteristic of a swamp will not usually be found in large numbers on a ridge. Since most field men can be trained to recognize through binoculars characteristic species at several miles distance, a good type map not only furnishes the location of many recognizable landmarks but offers an excellent key to the topography.

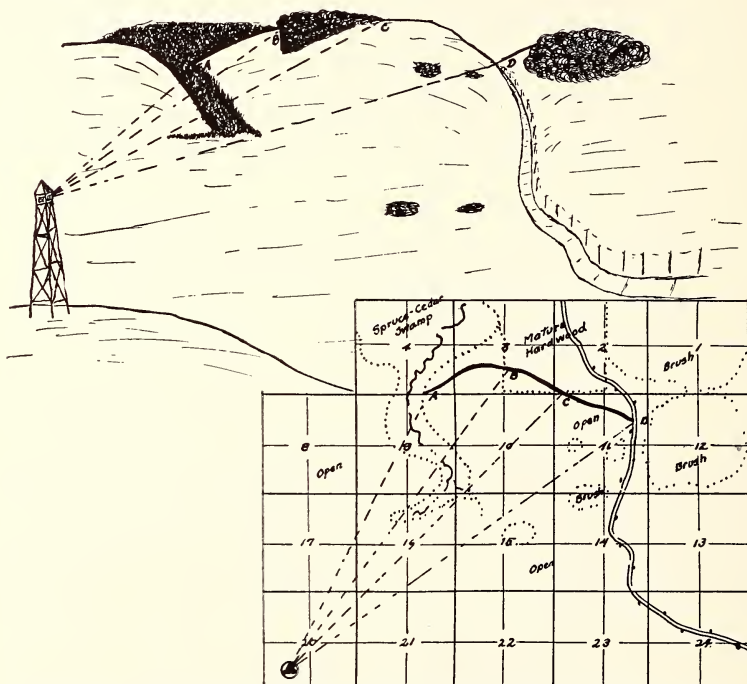
The illustration on page 20 represents the procedure which might be followed in determining the location of a mask and the width of its unseen area, using a type map.

The upper sketch represents the appearance of the landscape to the mapper, the lower the type map.

² While this term is relative, base features should be located within 200 feet of their true position.

³ For the purpose of this article, the word "mask" may be taken to mean any hill, timber, or other feature obstructing the observer's view.

A represents the point where the hill appears to come in contact with the swamp along the creek, *B* the left edge of a block of mature hardwood near the crest, *C* the point where the timber disappears over the hill, and *D* the spot where the road comes around the right edge of the hill. By sighting on each point and drawing rays as indicated to the known landmarks, the crest of the hill line *ABCD* is plotted. The outer rays *OA* and *OD*, projected, mark the extreme width of the unseen area.



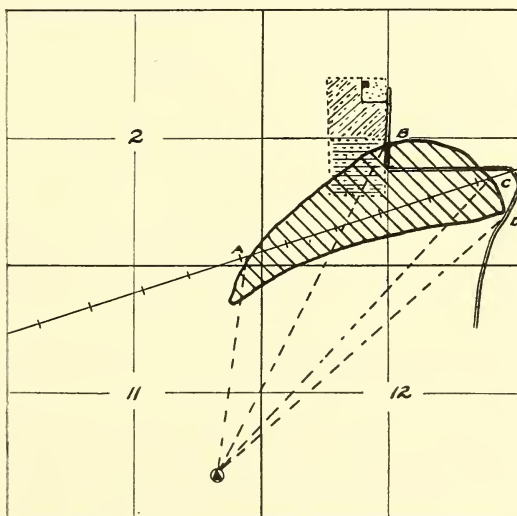
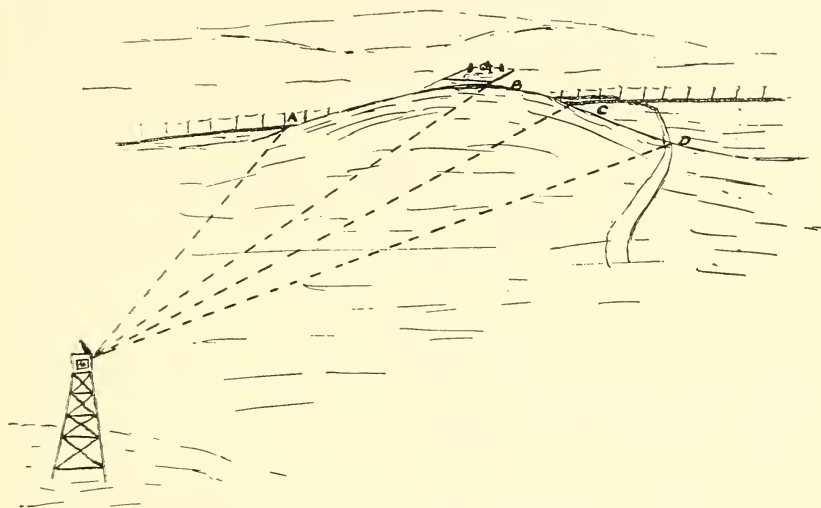
Sketch and map illustrating use of type map in locating crest of ridges.

But the determination of the length ⁴ of the unseen area is not quite so simple. One method commonly used may be called the landmark method. The observer in this case, having located the crest of the hill, picks out a landmark which appears directly above it. This landmark, building, road, lake, or other feature, marks the extreme edge of the unseen area. (See illustration, p. 21.) In this sketch, *A* indicates the junction of the unseen area and the railroad, *B* the edge of a field appearing just over the crest of the mask, *C* the point where the left edge of the unseen area crosses the railroad and *D* the intersection of the hill and road. On the map the crosshatched area *ABCD* indicates the unseen area as it would be shown.

In timbered country the type map unquestionably offers the best means of locating a large number of landmarks necessary to the system described, while in settled areas it proves almost as valuable in showing the location of scattered woodlots. In addition, it offers this further check: if the observer in a country where hardwood

⁴ The distance unseen behind the hill.

ridges and coniferous swamps exist is able to see only the tops of hardwood trees from the tower, he may surmise that part of the area is unseen, yet not know what part. On the other hand, equip him with a type map and he will know how much is unseen and its location.

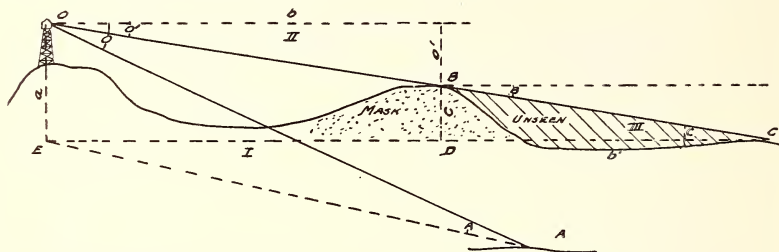


Sketch and map illustrating the landmark method of determining outlines of unseen area behind a mask.

Needless to say, binoculars are indispensable to accurate work. Frequently an area which appears solid to the naked eye may show up as a series of rounded ridges when viewed through the glasses. We cannot afford to let the optical illusions created by the lack of proper equipment influence the planning of our detection system.

In all of this work the fire finder or the alidade must be used continually to locate points and to plot edges of masks and the resulting

unseen areas. But there is another important use for these instruments: the reading of vertical angles. For, ideal as the landmark system may appear to be it fails miserably in some circumstances. Where unseen areas fall on jackpine-blueberry plains, cedar-spruce swamps, muskegs, or consistent level hardwood stands, the monotonous landscape offers few effective landmarks. Here the mapper has a choice of guessing at the length of the unseen area, or attempting to work out some effective means of calculating the distance.



Mathematical explanation and proof of the angle-of-site method.

Let O be the observation point.

B be the crest of a mask, at a known location.

C be the unknown point where the observer's line of sight intersects the ground or ground cover.

A be a landmark of known location whose elevation is approximately that of C .

Vertical lines are constructed through points O and B and horizontal (level) lines constructed through O , A , B , and C , forming right triangles I, II, and III, with angle A equal to angle O , and angles B and C equal to angle O' .

Angles O and O' are negative vertical angles measurable from the tower. Lines EA and b are scaled directly from the map.

$$(1) \text{ Then } A = \frac{EA}{\cot A} = \frac{EA}{\cot O}$$

$$(2) \text{ And } o' = \frac{b}{\cot O'}$$

$$(3) \text{ And } c = a' - o'.$$

$$(4) \text{ And } b' = c \cot C = c \cot O'.$$

$$(5) \text{ Therefore } b' = \left(\frac{EA}{\cot O} - \frac{b}{\cot O'} \right) \cot O' = \text{length of the blind area.}$$

Where the height of the mask (c) can be estimated, length of the blind area = $c \cot O'$.

In this proof the curvature of the earth has not been considered, since it was felt that this would be a negligible factor even at 10 miles distance.

Past experience on Upper Michigan has proved that the human eye is not an effective instrument for calculating horizontal distances where angles of less than 5° are involved. Since in this type of topography 90 percent of the vertical angles measured from any one tower are less than 2° , the chances of any individual training himself to consistently estimate the length of the unseen area behind hills of varying height at different distances are exceedingly remote.

Yet, at the same time, these hills all rise less than 500 feet above the surrounding plains, in fact the average is closer to 100 feet. How much more effective would it then be for the observer to estimate the height of the hill (to the nearest 20 feet, let us say) and calculate by trigonometry the horizontal leg of the triangle? Roughly, on a hill 100 feet high with a vertical angle of 20 minutes the chances of an

accurate guess would be 3,000 to 1 in favor of the latter method. Then if we further improve the technique by calculating the height of the hill, is it not likely that the method would prove the most accurate possible?

The angle-of-site method ⁵ developed on Upper Michigan calculates by trigonometric right triangle formulas the relative elevation of the top of the mask and the ground level behind it, then determines the length of the unseen area as one leg of a right triangle whose base is the difference in the above elevations and whose apex angle is equal to the negative angle of the top of the mask, read from the tower.

The illustration on p. 22, with its accompanying explanation, covers the formulae and procedure used in this mathematical solution. But accurate as this method is, it has one rather obvious weakness, the time required to complete the computations. Even if every field man called upon to make a seen-area map were a mathematical genius, the necessary time plus the possibility of arithmetical error would seriously discount the value of the system.

Realizing the necessity of making this technique practical, a simple scale was developed which reduces the procedure to the mere reading of vertical angles and the laying off of distances upon the map.

The above elevation—unseen space scale, shown above, consists of:

1. A 1 inch=1 mile scale⁶ graduated in miles and quarter miles.
2. A 1 inch=1 mile space scale reading elevation in feet over unseen distance in miles for angles of 10 minute variation.

In using this scale on a typical problem (see illustration on p. 25), the mapper would:

1. Plot lines from tower at *O* to points *A*, *B*, *C*, *D*, *X*, and *Y* as shown, extending line *OB* beyond unknown point *E* at the far side of the unseen area. (Point *D* is located on a definite landmark, whose elevation is approximately the same as the level ground in the vicinity of *E*.)

2. Sketch the crest of the mask as line *XY*.

3. Measure the negative vertical angles to *D* and *B*, recording them as 40 minutes and 30 minutes, respectively.

4. On the 40-minute scale (see fig. 5) lay off the map distance *OD* and read 210 feet, the elevation difference of the observing point and the landmark *D*.

5. On the 30-minute scale lay off the map distance *OB* and read 100 feet, the elevation difference of the observing point and the crest of the mask at *B*.

6. Since *E* and *D* were assumed to be of equal elevation the height of *B* above *E* equals $210 - 100 = 110$ feet.

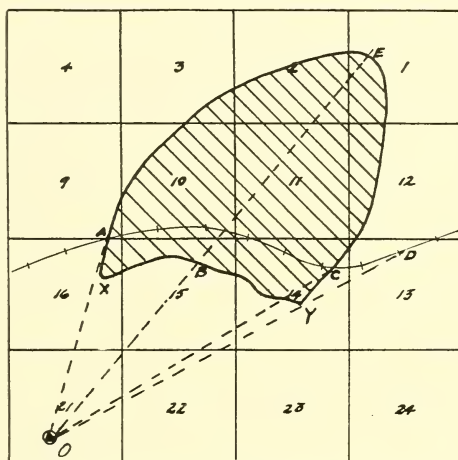
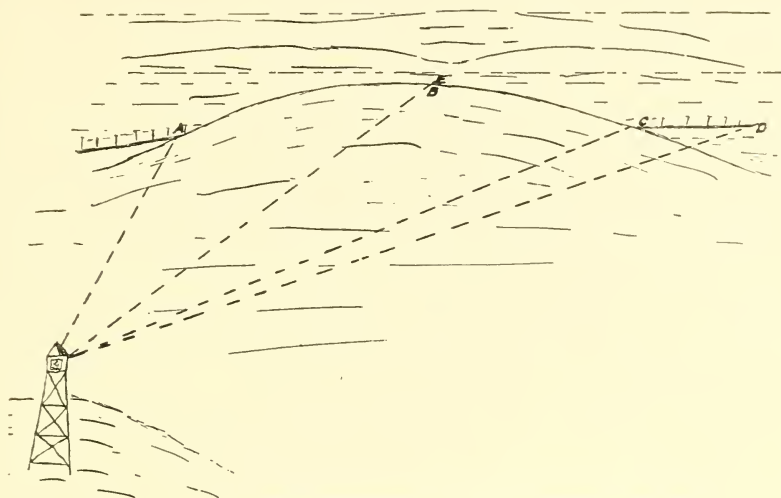
7. From the 30-minute scale obtain the distance equal to 100 feet and lay this off on the map as line *BE*, the length of the unseen area.

8. The cross-hatched unseen area *AXBYCE* would then be outlined.

In actual practice, a number of shots must be made for every mask, but the procedure followed is identical, except that the elevation of the mask can sometimes be estimated allowing the observer to cut out steps 4, 5, and 6.

⁵ So called because of its resemblance to the technique employed by the field artillery in computing the angle of site of a target hidden from the battery, but visible to the observers, in country where no contour maps exist.

⁶ Field mapping on Upper Michigan was done on a 1 inch=1 mile scale map. The scale and the map must be the same.



Sketch and map illustrating use of the elevation—unseen space scale as an aid to the angle-of-site method.

The angle-of-site method is designed to accomplish by mathematical means the work which profile plotting does graphically. In so doing it proves to be far more adaptable, since:

1. It can be used where no contour maps are available; the observer calculates his own relative elevations.

2. It is unaffected by the mechanical difficulties of plotting 10- and 20-minute angles, and for this reason is entirely workable in flat country.

3. When used with a detailed type and base map it takes into consideration *all* masks whether topography, timber, or buildings.

4. It is a mechanical method, it is easily taught, and consistent even when used by relatively inexperienced mappers.

AN EFFORT TO MAKE AERIAL SCOUTING SOMETHING BESIDES AN EMOTIONAL ESCAPE FOR THE EXECUTIVE

CLAYTON S. CROCKER

Fire Control, Region 1, U. S. Forest Service

Some 3 or 4 years ago I heard someone remark that one of the stumbling blocks in the quick organization of suppression forces was the lack of detailed scouting information. This has been true on all the fires I have known.

In attempts to speed up and to perfect scouting, we have spent much time and money, but still our scout maps and data reach the dispatcher and organizer far too late to be of most value. Usually the data obtained is inaccurate and incomplete. Something better is needed, and here's what has been done lately.

We have six office men in Missoula trained to take pictures, develop the negatives, and make prints while in an airplane over a fire. We have developed a home-made kit for doing this work and have converted an old 5 by 7 Graflex into a foolproof scout camera. The whole outfit weighs about 75 pounds.

Experiments show that inexperienced men on their first trip in the air can take, develop, print, and drop the pictures in 18 minutes. Some have done it in much less time than this.

While we haven't had a chance to try this out on a real fire, I am confident it will prove valuable. Advantages are as follows:

1. Our scout plane and a photographer can reach most fires in the region and put pictures into the hands of firemen, rangers, and supervisors before the local ground scout could hike around the fire.

2. Pictures tell a story in detail not possible to obtain from maps and notes. They eliminate chances for discrepancies inherent in any attempt to correctly visualize conditions described through the eyes of another person.

3. Pictures give the fire boss or the dispatcher up-to-date information. The ground scout can't.

4. Series of pictures taken periodically will provide data for rate of spread studies, and should be worth while for study by Board of Review.

Some prints made by trainees are enclosed.¹ These are the first attempted and in most instances were taken too high above ground. However, it will give an idea of the quality of picture obtained.

The plan is to take a series as follows:

1. From a distance to define location, major topography, etc.

2. Close enough to get the entire fire or sector. This to give details of size, perimeter, and intensity of burning.

3. Very close to show details of fuel, ground cover, etc.

If the thing is worth it, I shall be glad to write it up in detail for other regions. It has taken 3 years to get this to a stage where we could say it is feasible and simple.

¹ The prints are interesting, but since two of them show no actual fires and all of them would suffer greatly by transfer to a printed page, they are not reproduced herein.—Ed.

HOSE SCRUBBING MACHINE

K. G. SEDGWICK
Project Superintendent
and

K. M. MACDONALD
Fire Assistant, Nicolet National Forest, Region 9, U. S. Forest Service

Faced with the necessity of washing 6 miles of dirty hose after one of last summer's fires, members of the Nicolet personnel cast about for a quick, cheap way to clean the hose. The result was that Ken Sedgwick designed and constructed a machine to do the work. A patent, to be dedicated to the public, has been applied for.

During a period of 2 days of continuous operation (16 hours) the machine washed 26,600 feet of hose, with a crew of five men operating the machine and handling the hose. The crew consisted of a man to feed the hose in, one to draw it through, one to wash the ends near the couplings, and another to operate the machine. If the machine were to operate continuously, one or two extra men might be needed to carry the hose to the machine and unroll it.

The five-man crew was made up of FF men, paid at an hourly rate of \$0.25. Labor cost figures came to \$0.075 per hundred feet of hose. Average speed of the hose through the machine was 27.7 feet per minute, including time lost in placing the hose in the machine and removing it. Actual speed of the hose through the machine was approximately 40 feet per minute.

The costs for washing hose in this way are considerably lower, it is believed, than they would be if hose were washed by hand, although check figures on hand scrubbing time and cost are not available. The results are better than those obtained by hand scrubbing. The machine does not seem to damage the hose in the scrubbing process, although it tends to accentuate the folded edge which results from rolling the hose, but not appreciably more than hand scrubbing does.

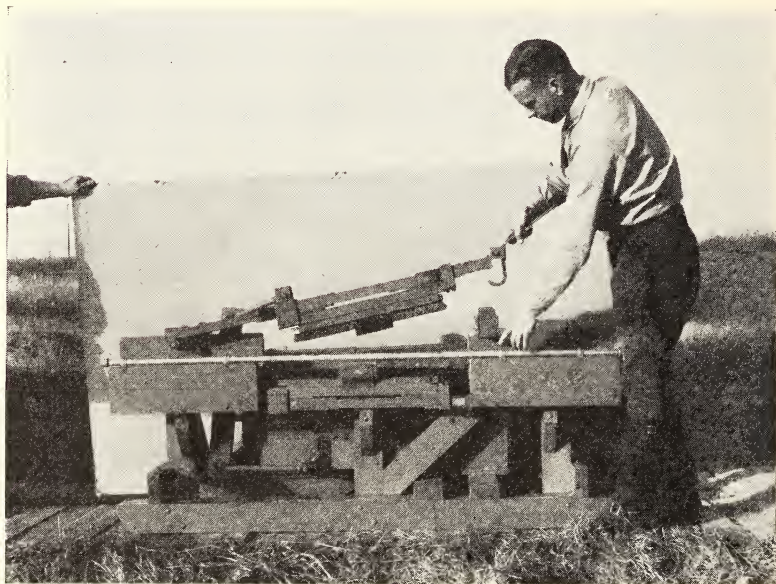
In operation, the hose is rolled up at the fire and brought in to the ranger station, where the machine is placed at the lower end of the hose drying rack. The hose is then run through the machine and drawn directly up on to the rack, where it is allowed to dry. It is then rerolled and stored.

The machine itself consists of a wood frame on which are mounted two sliding brush carriers, one above the other, each carrying two regular floor scrubbing brushes placed end to end. The lower carrier has the brushes on its top side, with the bristles extending upward. The upper carrier has its brushes on the bottom, bristles down. The hose is drawn by hand between the brushes, while the carriers are driven in an endwise reciprocating motion by a small gasoline engine. The stroke of the brushes is 2 inches, and the speed is 300 complete (forth and back) strokes per minute. The two brush carriers move in opposite directions.

Before going between the brushes the hose passes through a trough 19 inches long in which it is thoroughly wet by water spraying from holes in a ½-inch pipe. The spraying is continued as the hose goes through the brushes and then through another trough where it is rinsed off before leaving the machine. On the Nicolet, water for the

spray is supplied by a garden hose connected to the ranger station water system.

The upper brush carrier is so arranged that it may be raised while the machine is in operation, thus allowing the hose to be threaded through the machine without stopping the engine. The carrier is then clamped down and the hose drawn through by hand. The machine will not wash the hose right up to the couplings at the ends, so that in operation a man with a pail of water and a scrubbing brush washes by hand about 1 foot of hose next to the couplings.



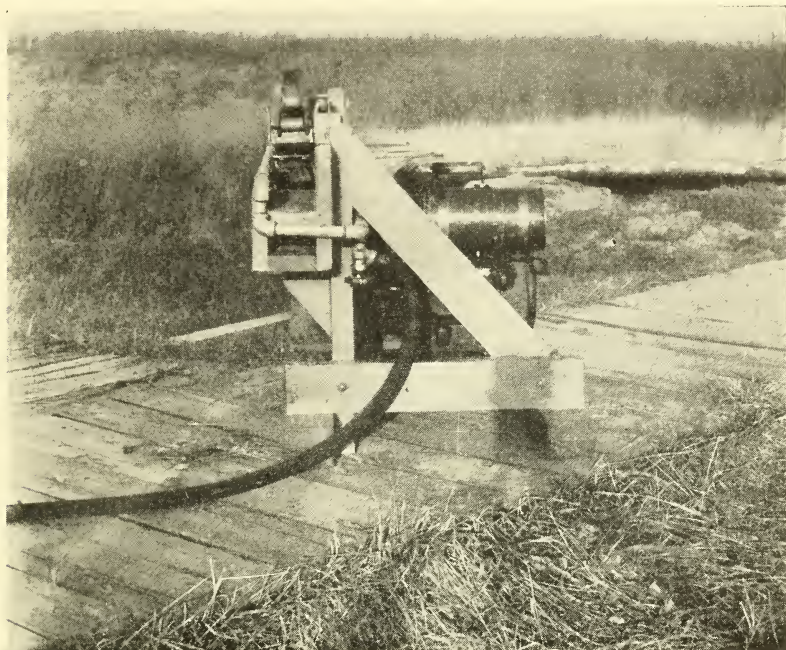
Front view of hose-scrubbing machine. Inventor holding the upper brush and pointing to places where hose is inserted.

In some cases the edges of the flat linen hose were not properly washed, so a pair of small vegetable brushes were mounted on the sides of the carriers, with their bristles extending horizontally inward. These remedied the trouble, but as the bristles were soft and wore out very quickly, brushes with stiffer bristles have been ordered. A set of regular scrubbing brushes is worn out in about 2 days of operation. They are easily renewed, however, as they are held in place with wood screws.

Motive power is supplied by a 1 horsepower 1,750 revolutions per minute Lawson single-cylinder gas engine, taken from a Forest Service portable power grinder. Power is transmitted to a crankshaft by means of a grooved pulley and V-belt. A connecting rod runs horizontally from the crankshaft to the lower end of a vertical wooden lever which is pivoted at a point about one-third its length from the top. A link from the top of this lever and another from a point two-thirds of the distance from the top connect with the brush carriers and transform the oscillatory motion of the lever into a reciprocating motion of the carriers.

The machine is 5 feet 5 inches long, 1 foot 11½ inches wide, and 2 feet high. Its weight is 282 pounds, including the motor, which is mounted directly on the frame.

The frame of the machine is made of 4 by 4 and 2 by 4 white pine, securely bolted together. The troughs, lever, and carriers are of 1½-inch yellow birch. No nails were used in its construction. All



View of right end of hose-scrubbing machine, showing locking clamp in raised position, hose connection and piping, motor, splash guard, brushes, and trough.

metal work was done by a Forest Service blacksmith. The crankshaft is carried in a pair of ball bearings from a tractor transmission. A sheet metal shield is installed between the brush carriers and the motor to protect the motor from water.

It is estimated that this machine can be built for approximately \$160, exclusive of the engine which supplies the power, although the designers' original model cost somewhat more. Power for the machine can be supplied from any available source.

A Simple Hose Reel.—Mr. Godden has developed an ingenious hose reel for winding hose to take it in after the fire is out or to move it to a new location. Very simply made from half-inch pipe, the reel is very portable and can be operated by one man. When the hose is reeled up tight, one side can be slipped off after the hose is tied, and the hose is easily removed.—From the article "Ready for the 1939 Fire Season," in the May 1939 issue of the *West Coast Lumberman*, which carries a picture of the hose reel.

LESSONS FROM LARGER FIRES OF 1938

ROY HEADLEY

Division of Fire Control, U. S. Forest Service, Washington, D. C.

The July number of Fire Control Notes included an article on larger fires on the national forests. "Lessons learned" from these fires were quoted from reports when they seemed interesting and suggestive. Quotations from reports on 1938 fires are continued in this issue. The fact that a "lesson" is quoted does not necessarily mean that the editors agree with the conclusions. Experience of individual men on individual fires should contribute to the body of knowledge and ideas shared by all who may have to manage large fires. Whether this particular method is the best way of making "lessons learned" available to all, is doubtful. Criticisms and suggestions are invited. Would you get more from full case histories and complete comments on a few larger fires? Or do you get more from these brief pointed statements of what men have learned from many specific situations? Remember that we are now limited to four 40-page issues of Fire Control Notes per year.

California Region—Continued

Trinity—Glennison Fire—370 acres.—This fire reached the size it did as a direct result of crowning through the unburned canopy on the day following control. Past records will show that this is a common occurrence on fires in the Canyon Creek areas, and a special effort had been made to mop up the entire fire before the burning period of the day following control.

In spite of the efforts of 65 men with backpack pumps and a power pumper, the fire flared up from inside and crowned out in the unburned canopy of live oak.

If there is any lesson to be learned from this experience, I believe it is the necessity of having enough men with water equipment to cover the entire fire before the beginning of the next burning period. This is a rather difficult and costly procedure, especially when control is not achieved before daylight. The flare up on this fire began at 12 noon, which did not allow much time to cover the entire fire. Also, it is not advisable to send men into the burn before it has had time to cool sufficiently to allow them to work safely.

Control of this fire the day following was achieved by following the above procedure to a large extent. However, weather conditions were more favorable until the late afternoon, which allowed more time to mop up.

In summarizing the above, perhaps the most important point is to achieve control as early as possible the first night so that the fire will cool down before daylight, and allow more time for mop up.

Trinity—Little Bear Wallow Fire—2,200 acres.—C. C. C. enrollees are ineffective on a fire when not thoroughly trained in fire suppression, and they must be accustomed to hard hiking in rugged country and able to do effective work after arriving at the fire. In the case of this fire, the initial attack was made by an experienced guard and two green enrollees. The boys, who were transferred here with a New York company a day or so previously, were soft, untrained, and not accustomed to hiking, and not only slowed down the guard's travel time to the fire, but were useless after arriving there.

Pack stock was badly needed in the early stages of this fire. The absence of pack stock prevented the setting up of a dry fire camp

to which food and water would have to be packed. Such a camp would have eliminated a long hard hike by fire fighters to and from the fire line.

The district dispatcher should be furnished adequate help both in the office and in the warehouse during a large going fire. He should not work over 20 hours on one shift.

Adequately trained men should be available to keep accurate records of all overhead and manpower on the fire line, or in the fire camps, and also to handle time slips and commissary supplies.

North Pacific Region

Siskiyou—Cedar Camp (Chetco) Fire—34,627 acres.—Something must be done to stop incendiary fires from being started to keep large fires burning. On the division in which I worked, it is a positive fact that one fire was set, and I am relatively sure that others were set in the same area. By way of a solution, the use of C. C. C. would probably be first, but in this case the C. C. C. was not available in sufficient numbers. Another solution, I believe, would be to use no crew not thoroughly supervised, even if it means using less men. For supervision, I believe that every straw boss unit should be led by a known straw boss. This would probably mean assigning many short term employees from other forests in cases of large fires.

Take the local man's advice as to fire behavior and wind drafts if he is reliable.

Reliable local men are indispensable as scouts, especially in unfamiliar country.

All trails should be brought up to at least secondary standards. More roads are needed in inaccessible areas.

Division bosses should travel more on saddle horses than on foot, to prevent fatigue.

After the first few days, do not work the men more than 10 hours, as little is accomplished after that period.

Two weeks of hard fire fighting is about all the crews or overhead can stand. They should be relieved for a rest period if possible.

Discharge camp agitators immediately.

Provide comfortable and clean camps for the men. Better output of work will result.

Food for the camps should not be ordered from an itemized list as this clutters up the air for a long period of time when the channels should be free for other fire business. Order by the standard ration list.

Select dependable men for night patrol. Many hours of hard work are often lost through incompetent night patrol.

Adequate commissary should be provided the men, especially tobacco and socks.

Make a written record of all orders given and keep carbon copies.

Pack trains were more dependable than airplane service in smoky weather.

Airplane servicing proved itself on this fire especially where camps had to be located where no trails existed. Food and supplies could be furnished immediately or ahead of the men.

The importance of radio communication cannot be overstressed. It played a vital part in the control of this fire. The ultra-high S sets were indispensable to the scouting units. Their compact size and the ease of operation make them a very practical aid in fire fighting.

As a presuppression measure, I feel that in the future when a lightning storm is reported near the district during critical fire weather, that at least a 25-man crew should be held in stand-by for immediate attack. Due to a policy of not hiring local men for fire fighting, much time is lost in obtaining outside help.

On the actual suppression of the fire, the following defects were noted: The service of supply was not able to keep up with the number of men placed on the fire line. The men were worked too many hours per day for efficient work. Some of the fire line was not burned out soon enough, resulting in loss of line. More efficient bosses were needed on the line to keep the men working. Many of the men hired were physically unfit or not properly clothed for fire fighting. Greater care should be taken in the hiring of the men. These comments are offered not in criticism but for guidance in the future. In general, as compared to other project fires which I have been on, I feel that this one was handled exceptionally well.

Siskiyou—Nome Fire—5,800 acres.—Planes proved to be an excellent means of supplying fire camps both from the standpoint of speed and economy. Camps were serviced that otherwise would have had to be supplied by man pack, as was done for several days when planes were grounded, which required 8 hours of hard packing by good men to get 40 pounds of supplies into camp.

Planes will not eliminate the use of horses. During the time that this fire was burning the smoke became so dense the planes were grounded for several days, which clearly brought out the fact that pack stock must be relied upon at times.

Training given short term employees paid big dividends. The experience brought out the fact that we have a thoroughly competent, industrious, and efficient short term organization. It is believed that more could and should be done to give these men longer employment.

The lack of enough dependable foremen was in evidence. It is believed that more short term employees from other forests should be assigned for foremen and straw boss jobs on large fires, particularly in this area. (Both sides of this gamble must be considered. Sometimes the district loaning men has suffered.—Ed.)

Because of lack of trails in the area in which this fire burned, it was impossible to get enough men in to the fire in time to keep it from becoming a conflagration. At one time it was necessary to shift a camp 2 miles airline distance. Because of lack of trails and the rough country, it was necessary to hike the men 18 miles and truck them 6 miles.

It is useless to send men unless they are accompanied by a competent foreman in the proportion of not less than 1 foreman to 25 men. Practically all the errors on this fire can be traced definitely to lack of competent foremen overhead.

More use should be made of the indirect method of control on fires of this size and in this type of topography. There is always the human aversion to burned area that is continually cropping up on fires of this kind. Men work too close to the fire, thus sacrificing time and labor.

More satisfactory results can be obtained by dropping back and taking advantage of natural breaks in topography.

A stream, unless it is large and clear of brush, makes a poor fire line. The variable winds up and down streams, the possibility of rolling logs and falling snags, and the rapid spread of a fire up the slope once it crosses a stream, makes it exceedingly dangerous to use.

Siskiyou—Old Diggins Fire—4,207 acres.—On back country fires, the available pack stock for supplying crews must be given consideration hand in hand with the calculation of probabilities and the ordering of men to meet this calculation. Very difficult situations arise because of inability to supply crews on the line.

Strength-of-force plans for the district should be revised so as to include more intensive control during periods of bad fire weather and low visibility. This pertains particularly to areas where incendiarism is recurrent.

There is a need for a lighter, more compact backfiring tool to be included in our smaller fire fighting units.

For areas where incendiarism is a problem, funds should be available for hiring small crews for work on roads and trails, so that they will be available and close at hand for suppression.

Siskiyou—Siskiyou Fork Fire—1,396 acres.—The fatigue factor from walking long distances through brush and over rough ground must be considered in predicting output when men reach the fire. Such men on the initial attack will not do the work per hour fresh men or those transported to a fire will do.

Observations made from the air are often misleading, as it is difficult to tell accurately the actual conditions or resistances to control encountered on the fire line.

Siuslaw—Smith River Fire—27,500 acres (mostly outside).—The necessity and practicability of camping fire crews on the job, even if water must be packed by man power, was emphasized.

In some cases the fire line was constructed on the fire slope of a ridge instead of the opposite slope, which resulted in a difficult job of burning out.

Fremont—Bonanza Fire—9,155 acres.—The large area and rapid spread of this fire was due entirely to the dense and continuous stand of "cheat grass" (*bromus tectorum*) with very little timber overstory. Consequently, the usual "forest" fire standards are not fully applicable. However, the following was learned about this particular country.

1. Must keep roads cleared as fire breaks.
2. Must construct additional cross roads.
3. Must make definite plans for suppression (outline prepared).
4. Overhead, in general, needs more "mop up" training.
5. C. C. C. enrollees must be shown "how" by fire foremen and straw bosses.
6. On very large fires it is better to use machinery for trench construction at the sacrifice of some acreage than to depend on hand work too close to the fires.

Investigation of the cause of break-over on August 26 showed that while a good trench and clean burn had been obtained on the extreme southeast corner of the fire, and mop up had been carried back of the line an adequate distance for ordinary circumstances, the crowning of a small green pine tree on a low ridge about 300 feet inside the line

threw sparks into the thick cheat grass and juniper timber which quickly crowned and spread under the brisk breeze. Men working in the vicinity of the break took action almost immediately, but were unable to cope with the heat of the crowning junipers and did not have time to use the indirect method.

Olympic—Green Mountain Fire—1,500 acres.—The lookout covering this area was on a patrol trip to a supplementary point and did not discover the fire until 15 minutes after it had been reported by the operator. It is always possible that this 15 minutes might have saved the day; however, due to an east wind and the fact that 15 men were unable to hold the fire a few minutes later, this too is doubtful.

There is also the possibility that had the pumper been put into use immediately upon arrival of the first crew, that they might have been able to drown this fire.

Rogue River—Trail Fire—1,089 acres.—Each sector boss should have a competent scout who is an experienced fire fighter to assist in locating lines and scouting ahead and who is responsible to him only. Other scouts working for the fire boss work at large and are often of no value to the sector boss who needs information on the line.

Scouts should not be men who merely know how to map and hike, but should be the best fire fighters available—men who know fire behavior from experience and can realize dangerous situations.

The camp manager should be a man who not only knows clerical work, but a man who knows fire fighting and requirements on the fire lines. This man should be the next important man to the fire boss.

A property or tool man charged with the responsibility of checking tools in and out and supervising the reconditioning of tools should be assigned each fire camp.

Related to the above is a question as to whether men should carry their tools back from fires, leave them on the line, or release them to relief crews. I am of the opinion that hand tools should generally be carried out for the following reasons:

1. Allows better control to prevent loss and theft.
2. Enables reconditioning of tools and means better tools on line.
3. Not apt to have tools one place and men another.
4. Prevents mixing of tools owned by different agencies.

On this fire the C. C. C. carried their tools out and the locals did not, and some of the above points were well illustrated.

A "camp boss at large" over three fire camps and assisted by a camp boss at each fire camp proved to be a good idea. In this way there was good correlation of activities between the various camps. All supplies were ordered through this man from the SOS unit.

Rocky Mountain Region

Roosevelt—Jenny Lind Fire—664 acres.—I believe the most important point to be noted is the great difficulty of insuring adequate initial action on a very aggressive fire in its initial stages. (Three miners, 100 feet away, saw fire and attacked it 5 minutes after it started. District ranger with one man arrived at fire 35 minutes after it started. But larger crews did not reach fire in time to prevent 39- to 54-mile wind from starting fire on its first run. Probably most important lesson to be learned is that on a forest not provided with regular

detection and other facilities common western fire forests, a fire starting in slash in a gale of wind could be and was stopped at 664 acres.—Ed.)

Almost uniformly there was too much tendency to bury burning material along the fireline in such a way that it only prolonged the burning and the mop-up period. The correct use of dirt has been so much emphasized that there are few if any of the foremen ignorant of the undesirability of partially burying heavy material; but there seemed to be great difficulty in getting this particular fault corrected.

A common fault which was perhaps the most serious was that of inclosing ragged fire perimeter inside a line without taking any measures to clean burn. This needs to be given a great deal of emphasis on all forests.

Southwestern Region

Gila—Canyon Creek Fire—502 acres.—This fire was started by a new employee of Mr. Adams, who was reputed to be a very careful man with fire. This emphasizes the need for personal contact with the permittees and employees which the rangers do carry out on this forest. The Gila rangers make a concentrated effort to contact all permittees through the whitling medium which I feel is the best method for this class of case. (But good as "whitling" is, it can't be done with everyone whose tendency to be careful with fire needs strengthening. Often there is time for no more than a few words—but those words need to carry ideas which will stick like cockle burs. For the benefit of readers, who will suggest such ideas, phrases, slogans which will stick, for use in the quick contacts which are so often the only ones possible?—Ed.)

Gila—Lookout Ridge Fire—575 acres.—Class 6 burning conditions prevailed and were not recognized. The fuels were very dry and the wind was strong. The lesson learned here is that a fire danger station would have furnished a definite check on burning conditions, and this could then have been promptly followed by proper strengthening of the guard force to meet class 6 or emergency conditions. (This forest is now supplied with a fully equipped station. Danger stations and danger ratings are designed to avoid just this sort of failure to recognize changes in fire danger.—Ed.)

Poor line location due primarily to trying to hold fire to a minimum acreage with subsequent loss of excess acreage was an important factor. This is merely a matter of training in suppression. (Yes, but training in judgment, which is the most difficult and most backward field of training.—Ed.)

Gila—Iron Creek Fire—2,318 acres.—Here again class 6 burning conditions existed unrecognized.

Too much line was lost by working too close to the fire. (Understand that this fire and this weakness were used by the region for training by the case method.—Ed.)

Width of fire lines must be governed by (a) fuel on ground; (b) steepness of slope; (c) wind velocity. In the past, fire lines have been entirely too narrow for safety in handling backfiring in windy weather. (Importance of training in judgment again emphasized. More common error is to make fire lines wider than need be for backfiring.—Ed.)

Intermountain Region

Wasatch—Shepherd Creek Fire—960 acres.—Particularly significant is that the fire, carried by a high wind, spread over 700 acres within 2 hours after it started. It traveled so fast that the fire truck, plow unit, and men could not keep pace. Forty men were on the fire within 20 minutes after it started, and, with our fire truck which suppressed a mile of fire edge, and the plow unit that made over 3,000 feet of fire line, it was impossible to cope with the high rate of fire spread. (But the wind dropped and the fire died down, after which the crews had a chance and did not muff it. An important principle is that the front of a fast running fire is often untouchable. But a lull always comes. The job is to be sure to grab it for keeps during that first lull.—Ed.)

Eastern Region

George Washington—Panther Gap No. 2 Fire—478 acres.—Fires had previously occurred along this portion of the C. & O. Railroad track. Inspection in February 1938 showed that the right-of-way was in very poor condition. This was brought to the attention of the section foreman personally and to the division superintendent by mail. No follow-up inspection was made.

Action on this fire, which was on a mountainside and almost entirely visible from the road, indicates that the hard and fast rule of requiring the district ranger (fire boss) to remain on the fire line is not always satisfactory. By remaining on the road with the whole fire spread out before him and with an adequate messenger staff, it was possible for him to know more about what was actually going on and be able to take quicker action than he could have on the actual fire line. In my opinion, the definite rule that the fire boss must remain on the fire line, in many cases, results in failure of suppression forces to take prompt action at critical points due to the very inaccessibility of the fire boss by putting him up in the front line trenches when he should be in a position where he can control the actual movement of his forces, both combatant and reserve, on the basis of what is happening on all points rather than just the local hot sector where he happens to be at the time a decision must be made. (This poses a problem which calls for more attention, more critical experience, and more carefully recorded experience for the benefit of all. Here is the dilemma on those fires where there is any real choice as to the method the fire boss follows in this respect. If he goes on the line, he will get the feel of the job in a way which cannot possibly be done through others. He can therefore, act more intelligently on the particular fire, and will also increase his priceless fund of direct fire experience. But as Supervisor Howard brings out in the above quotation, he will lose some control of the work on the job as a whole. Some men who have managed fires from a base camp with the aid of scouts, messengers, and a map laid out in the dust, are enthusiastic in favor of that method. Others say that a competent fire boss makes plans and issues general instructions; that frequent decisions are likely to gum things up; and that the fire boss can work through messengers and scouts while moving around the fire, as well as from a central point. If it is a matter of skillful discrimination between fires which

call for one or the other of the two methods, what criteria may be set up to enable a fire boss to judge quickly and accurately which method is best for a particular fire?—Ed.)

Southern Region

Conecuh—"Boss" Fire—496 acres.—The fire area was about 30 acres on arrival. This can only be reduced under the prevailing conditions, by closer placement of suppression equipment. Maximum travel distance now 10 miles. To halve this distance would quadruple the number of fire crews. Question: How much can we afford to spend to reduce area on arrival? Certainly 30 acres is too large. (Since this fire only burned 64 acres within the protection boundary, it did not come within the definition of fires of over 300 acres; but it is included here because it raised in the minds of forest executives a question of such fundamental importance to socially-minded management of fire control.—Ed.)

Conecuh—"Big Fire"—576 acres.—In the attack on this fire, as in most other fires on the Conecuh, (wire-grass type of ground cover), everything depended upon the success or failure of the tank truck. From the time of attack with this truck until the water supply was exhausted (15 minutes) 19 chains of line were built. A reorganization has been made to provide for replenishment of the supply of water for the tank truck.

The fact that the first crew boss on the fire did not assume the role of fire boss contributed to confusion and loss of acreage. Intensive training in the duties of a fire boss is being given all crew bosses.

A whirlwind picked up burning material from as far as 100 yards inside the line and dropped it outside in the rough, resulting immediately in a break-over of large proportions. On at least two occasions whirlwinds hit the fire line while suppression was being carried on with tank trucks, resulting in loss of short lengths of line and excessive use of water. Variability of wind direction and prevalence of whirlwinds are factors not ordinarily considered in danger rating.

Evidence indicates there was time to have cut a line and back-fired across the head. This would have speeded up control and promised better chance of holding to a smaller acreage.

Conecuh—Long Fire—442 acres.—The more basic problem, the elimination of the grazing fire as an element of risk, is, of course, being attacked from the educational angle, and some progress has been made in convincing stockman of the advantages of rough woods. However, the problem is intimately tied up with the regulation of grazing on the forests and warrants much study as well as administrative attention. The risk of stockmen's fires will likely be present on the Conecuh for some years. (The 1938 record on the Conecuh is so much better than for previous years as to suggest that progress has indeed been made on this outstanding problem of the grazing fire.—Ed.)

Conecuh—Bradley Fire—792 acres.—The education of local residents has not yet reached the point where they can be depended upon to follow all accepted principles in respect to debris burning. In this case, a line was plowed around a field and the fire set to burn into the wind. But the rancher failed to realize the high danger involved when burning at 10:30 a. m. Had this burning been deferred until

late in the afternoon, there is no doubt but what the fire could have easily been confined to the field being burned.

It must be admitted that we do not yet have on the Conecuh equipment capable of stopping a large fire under severe burning conditions. Since the occurrence of this fire, our tank trucks have been improved somewhat by the use of a larger nozzle opening. This increases water consumption, but permits attack on a somewhat hotter fire. On later fires the use of two tank trucks abreast has been tried with some success. There is also a possibility of delivering more water from one truck by the use of two hoses.

There is a definite need for a mobile tractor-plow suppression unit, capable of rapidly plowing a line from which backfiring could be done. This type of equipment appears to offer the only practicable means for stopping the head of the occasional bad fire short of natural breaks.

The relative humidity on the day of the fire (December 3) did not reach a point that could be called low. This shows that relative humidity, in itself, cannot be relied upon as an indicator of fire danger.

Ocala—Pleasant Flat Fire—2,161 acres.—Our means of transporting men and equipment in the conventional type truck is unsatisfactory for the sandy roads on the Ocala. We plan to overcome this obstacle by replacing our conventional fire trucks with four-wheel drive trucks as rapidly as funds become available.

The ground of the timber type through which this fire burned is generally covered with water during periods of normal weather, but dries out several times a year so that it becomes inflammable. Since it is not very accessible by tank trucks, the construction of permanent meandering 8-foot firebreaks on the higher ground within the type will prove very helpful in suppression of any future fires which may occur.

This fire was also the first on which we used the new Mathis or Columbia two-disk plow equipped with a rolling colter. This equipment proved very effective, and with minor changes will become an important piece of suppression equipment.

Summarizing, I would say that the most important thing this fire showed was the inability of the ranger to make efficient use of the manpower and equipment that was available at the time of the fire. The matters of new and better equipment are secondary. (The ranger may take comfort from the fact that many others, including big shots in fire control, suffer from the same inability—but this should not deter him from seeking to be mentally prepared for efficient management of the next fire.—Ed.)

Choctawhatchee—Sandy Mountain Fire—2,381 acres.—The equipment we were using was in poor, worn-out condition and failed on the fire line. This has since been corrected by a new tank truck which has been built and equipped with a power take-off and centrifugal-type pump.

Burning the boundary biannually is not sufficient to cope with the control problem of exterior fires. To remedy this we plan to burn a strip having a minimum width of 300 feet around the north and east boundaries each year; this will give us a 300-foot strip freshly burned adjacent to a 300-foot strip with a 1-year rough, and it is felt that this will form an adequate base from which a backfire can be set.

The fire-training meeting that followed this fire indicated that our previous method of handling fire-training meetings was not reaching

its objective. The most effective means of discussing strategy in fire control we found to be the drawing of an actual fire on the blackboard by one member of the group, picturing the fire as it was when he arrived. He wrote on the board all of the actual conditions, that is, men and equipment that he had, size of fire, condition of fuel, direction and velocity of wind, time of day, land status, etc. In other words, I wanted to eliminate from the very start the pet answer, "it all depends." Each member had an opportunity to describe or to lead a discussion on one or more fires that he had been on in the past several years. After placing all the information on the board portraying the fire as it was when he arrived, he would then ask different members of the group what they would do under like conditions. After the fire had been thoroughly discussed, the leader of the group would then tell them what he did and what the results were.

I felt that this was probably one of the most effective fire-training meetings I had ever attended because every member was eager to describe his experiences and to criticize the action that had been taken on the other fires by other persons, and the opinion of the group after the meeting seemed to indicate that they had all gotten quite a bit out of the meeting.

Kitsatchie—Big Fire—650 acres.—It takes considerable training and actual fire fighting to get C. C. C. crews up to the output of 6 chains per man-hour which was attained on this fire. To insure such an output for the future, all C. C. C. members of companies used for fire suppression must be put through an intensive 3-day fire school at least four times a year. The rapid turn-over of enrollees makes the quarterly fire school absolutely necessary. If enrollees are properly trained and well led, 6 chains per man-hour can be maintained without any undue trouble. (More power to Supervisor Bryan, the author of these brave words. The weighted average output per man-hour on the 25 larger fires in region 8 in 1938 was 1.67 chains.—Ed.)

This was a man-caused fire set for grazing purposes. It probably was not the intention of the trespassers to burn Government land. However, the fact that it did burn Government land did not worry them very much as it was just additional burn for their stock to graze upon. Fires originating outside of our fire and national-forest boundaries are, as a rule, more dangerous than those arising inside. The reason for this is simply that they are farther from the centrally located source of manpower, and by the time a crew reaches them they are so large that control is exceedingly difficult. The Kitsatchie Forest had five 300-acre and larger burns during the 1938 season. Three of these fires originated from so-called grazing sets which occurred outside of the national-forest boundary. When one considers that 90 percent of the land immediately outside of our boundaries burns at least annually, it is not surprising that some of these fires will cross the boundary and burn national-forest land. State fire laws are not enforced, and the area outside has no protection except that afforded by its proximity to national-forest land.

It is the opinion of this forest that the outside fires will never be completely solved until the outside area is placed under protection. The grazing of cattle, horses, sheep, and goats conflicts directly with fire control. Regardless of who owns the land, stockmen, as a general rule, are going to burn in the spring if they think they can get away with it. We can, in a measure, stop them from burning

outside by fire-prevention talks, law enforcement when the fires set endanger Government land, and general educational programs. However, the real solution for outside fires is protection for that area.

This forest in the past spent most of its time and money on fire prevention within the boundaries. The number of fires within the boundaries have been steadily decreasing, and it is now our problem to stop the setting of those fires around our boundary which could possibly creep over to Government land. This is a large job, as our boundaries are long and a large number of people live just outside. It will take several years to make much headway, and the problem will never be settled until this outside land is put under adequate protection from fire.

Kisatchie—Honey Fire—1,092 acres.—In this case the fault lies with the fire boss in his failure to recognize extreme fire conditions that existed on January 25, and to modify his attack to fit these extreme conditions. If he had realized, or had had means other than his general knowledge and experience to guide him in selecting the correct method of attack, the fire would have been controlled much easier, and with a somewhat smaller acreage. Instead of attempting a direct attack, had he backfired all existing roads and firebreaks facing the oncoming fire, the fire would have been controlled at about 700 acres and the slash-pine plantation inside of the fence would have been saved. The amount of held line per man-hour would have been at least tripled. One answer is a well-constructed fire-danger meter which will leave as little as possible to the judgment of the fire boss on the fire line.

The only method of controlling this fire at a smaller acreage after it had started would have been an immediate attack by the indirect method of backfiring. Under such conditions, tank trucks and specialized equipment are of very little value. A strip of burned ground at least 400 feet wide is necessary to stop the heads of such a fire.

The fire was started by the L. & A. Railroad train which was temporarily stalled at the point of origin. The Louisiana State law requires that the railroad free their right-of-way from combustible material. The forest has never been able to force the L. & A. to do this. The railroad officials have been warned, both in person and by letter, many times. Also, they have paid suppression cost and damages for other fires caused by their railroad. Railroad business is rather poor, and the officials took the attitude that they could not afford to keep rights-of-way clear as required by law. Reimbursement for damages and suppression costs amounting to \$2,160.62 has been asked for.

Since this fire occurred, however, the railroad officials have decided it is cheaper to clear the right-of-way than to pay damage and suppression costs. Both the L. & A. Railroad and Missouri-Pacific Railroad Cos. have cleared their rights-of-way of combustible material within the forest boundary. For the first time in the history of the Kisatchie Forest, we will enter the 1938-39 fire season without the constant hazard of railroad fires.

Fusees used for backfiring in some of the tool boxes had absorbed enough moisture from the air to be worthless. The wet or damp fusees could not be detected by casual examination. Some delay in backfiring was caused by these dud fusees. Fusees cost only about 9 cents

a piece, and this failure could have been eliminated by simply replacing old fusees with new ones every 30 days.

Kisatchie—Slash fire—407 acres.—Two hundred and ten acres of the fire had only recently been planted to slash pine. The slash pine of course was totally destroyed. The rough was composed of wire grass, broomsedge, and a fairly heavy carpet of hardwood leaves. The rough was of 5 years' accumulation, and can be considered heavy for longleaf type.

Investigation revealed that the fire was handled very well by the lookout men and the dispatcher. The discovery, report, and get-away times are excellent. However, the decision of the superintendent to send only 6 men with the junior foreman in a pickup to check on the fire was sadly at fault. The day was not an extremely bad one; however, a fresh south wind was blowing and any fire located within a quarter or a half mile south of the boundary certainly should have merited both the fire truck (tank truck and Panama pump) and a full 16-man crew with the standard fire-fighting tool box. If the junior foreman had had a full 16-man crew and fire truck he would have unquestionably held the fire with only an acre or so of national-forest land burned.

Kisatchie—Cactus Fire—488 acres.—The C. C. C. enrollees from the State camp had only been at Fullerton Side Camp about 10 days at the time of the fire. They had been transferred there to assist in the heavy planting program. These men were absolutely inexperienced in fire fighting and, consequently, had only what training could be given them in this time. It is little wonder that they became panic-stricken on a fire such as this, not having had the chance to gain the experience necessary on fires of lesser severity.

The seat of this lies in the decision of Superintendent Warner to keep his men separate from the enrollees of the home company. This was a wise decision from the standpoint of supervision of the men on the planting job, but left a woefully weak point in the fire-fighting organization.

When it is necessary to augment our regular camps with additional men for a heavy planting program during the fire season, there will be a split of men in such a way that we will be assured of a good sprinkling of well-trained men in every crew. This will be an addition to an intensive training program for all new men.

Kisatchie—Boom Fire—877 acres.—This was an incendiary fire and was the result of four separate sets. These fires were not set by local residents. The area is grazed heavily only in the spring and early summer when cattle are driven out of the swamps by the backwater of the Mississippi River. Many of the stockowners who graze their cattle on the forest at that time live and normally graze 30 or 40 miles away. These men are not interested in growing trees, but are solely interested in good grazing for their stock. They firmly believe that a fresh burn is much better than a rough at that time of the year, and many of them will resort to nearly any measure to get the burn desired. Better law enforcement is one of the answers. Control of grazing by fencing and issuing permits is another. Fire-prevention contacts with stockmen will also help. Next winter the forest plans to have at least one man roaming this area on foot or horseback for the sole purpose of apprehending at least one trespasser. One con-

viction on a criminal charge of wilfully setting fire will unquestionably do more real prevention work than anything else.

DeSoto—Saucier Fire—635 acres.—The weather conditions made the hazard extreme. There had been no rain for 3 days. The relative humidity was 33 at noon. Wind velocity varied from 8 to 16 miles per hour during the fire. The ground cover was broomsedge grass. The flames had a range of 40 to 60 feet, crowning at times and spotting ahead.

Instructions were to backfire from a fire lane on the west side. This firebreak had been constructed 2 years ago and had not been maintained since this time. As a result, it was grown over and offered no effective barrier from which to backfire. The extreme weather conditions made it improbable that even if the firebreak had been recently maintained, the crew would have been able to hold their backfire on this narrow line.

DeSoto—Hell Hole Creek Fire—509 acres.—This fire emphasized how immediate and continued work on the flanks of a large fire can keep the acreage to a minimum and prevent new heads from forming when the wind shifts. Crews worked the flanks continually so that when the head was finally stopped the entire fire was corralled within a very few minutes.

The head of this fire presented a wall of flames 20 feet high, with a range of 30 to 40 feet. It was burning in a 5-year rough. Several of the fire fighters had narrow escapes while attempting to stop the head. Two different pump men were forced to abandon their pumps in order to outrun the fire.

This fire, as well as other large ones on the DeSoto, shows that in extreme weather conditions a great deal depends on the dispatcher's judgment in placing crews, not only for the head but for work on the flanks. The speed at which these fires travel offers little opportunity to correct tactical mistakes on the fire line.

North Central Region

Chippewa—Lundeen Fire—370 acres.—Training plans must be flexible enough to provide for abnormal years. Training plans called for the training of the dispatcher and lookout men prior to our normal fire season, but as the spring fires started 25 days prior to our normal season the dispatcher and lookout men were inadequately trained. It is believed that this fire would not have reached this size had the men been given more thorough training. The area when reached was estimated at 60 acres.

Areas of this type should be burned over in the spring when conditions are safe and snow is present on the high land, as areas of this type are used for pasture by local settlers. If not burned, they will be set by the local settlers when weather conditions are favorable for burning.

The action by the suppression forces was satisfactory, with the exception that a scout should have been used to reconnoiter the fire and secure any clues or evidence as to the individual or individuals responsible for setting the fires.

Gardner—Tower Fire—489 acres.—This was one of a series of 25 fires burning on the district on this date. The fire danger was class 6 and the wind velocity was 20 miles per hour. The fire spread rapidly in highly inflammable leaf and grass fuel. Topography was rugged

with steep slopes, which accelerated the rate of spread. Winds shifted frequently and small whirlwinds occurred along the fire front. As a result the fire had a number of heads, with one traveling along the top of each main ridge. The fire advanced in a solid sheet of flame, leaping 6 feet high in most places, and the men could not get near the fire because of the intense heat. Spot fires, jumping in many cases over 100 feet ahead of the main fire, were common. There was 2 to 3 years accumulation of leaves on the area.

When Assistant Ranger Barry arrived, he took charge of the fire immediately. He made a quick size-up of the situation, determined that direct attack was ineffective (It had already failed.—Ed.), and directed the crews to drop back several hundred feet from the fire edge to construct line. The technique used, which consisted of raking a line and backfiring from it, was considered satisfactory under the circumstances. This dropping back was essential because whirlwind conditions caused fires to spot 100 to 200 feet ahead of the main fire.

Knowing the conditions as are known now, fire management could have been improved by backfiring from the truck trail and keeping the fire from crossing it. However, the use of this technique would have required at least 25 additional men as there were separate heads traveling toward the road.

The district personnel feel that bloodhounds could be effectively used in tracking down trespassers; merely the knowledge that bloodhounds were being used for this purpose would make the local residents less apt to set wild fires. When this matter was taken up with the regional office however, the use of bloodhounds was opposed for several reasons, the principle being that bloodhounds are usually associated with running down murderers, kidnappers, and other criminals in that category, and should not be used as a deterrent medium for reduction of man-caused fires. (But after years of fairly successful use of bloodhounds in a small way, the southern region feels that the use of dogs for this purpose should be greatly enlarged.—Ed.)

The general belief that all fires in Missouri hardwoods can be handled by direct or parallel methods is false. On certain days, conditions are such that the only practical method is to drop back to natural or cultural barriers, such as the road in this case, and sacrifice some burned acreage in order to insure control.

A more extensive use of water should be resorted to on such days. On this fire three men could not control a 5-foot spot fire by use of rakes. A marine pump would have saved the first line built on this fire.

Gardner—Flat Fire—302 acres.—This was the only fire burning at the time, and most of the enrollees were in camp and available. Therefore, in view of the available manpower, wind velocity, darkness, and possibility of multiple sets, the dispatcher was justified in sending 31 men instead of the usual smaller initial attack crew. It is our policy to send more men to night fires during hazardous periods, since experience has shown that travel time is slower and held line production is usually very low.

Gardner—Brookshire Fire—412 acres.—As a result of our experience on this fire, an organization of fireguards and suppression squads paid from P. & M., F. C., and F. F. was set up at strategic points to supplement C. C. C. during critical days.

The held line constructed per man-hour on this fire was three chains. During periods of class 6 danger, with a wind of 20 miles per hour, held line construction is necessarily slow because of the need for a wide line and careful patrol immediately behind the crew to keep the burning leaves from spreading across.

This fire was set and tended by local residents. They were intent only on burning their own land and claimed to be unaware that any Government land was inside their fence. A contact with Mr. Brookshire warning him before the fire was started might have prevented it. However, he was taken before a justice court and pleaded guilty. This action should have a very desirable effect in the locality for fire prevention.

Gardner—Thurman Junction Fire—412 acres.—The slopes on most of the burned area were between 40 and 50 percent, and in some cases much steeper. A strong wind prevailed, as was evidenced by a large number of tree tops broken during the time the fire was burning. At least 60 different places were set afire along the bottom of a deep dry ravine for about $1\frac{1}{4}$ miles. The fire spread rapidly up both slopes. The change in tactics used by the person setting this fire is of extreme importance in this locality. Previously, sets have been made by following the ridges. In this case, sets were made in the bottom of a deep hollow in the most blind place possible. As to prevention, controlled grazing with definite allotments would probably have eliminated this fire.

Superior—Sand Creek Fire—329 acres.—Most of the line was made with a tractor and plow. Need was emphasized for a foreman with good judgment to direct the furrowing crew in line construction. This is necessary to shorten the amount of line by cutting across burning points, and burning out, especially where low timber values are involved. (Why use up a foreman on line location at which he may or may not be expert? Why not train a cat-skinner to locate his own line, or when that is not practicable, have him directed by a man who, while not a foreman, is skilled and trained in the art of line location?—Ed.) This point was very outstanding on the fire as the furrowed line followed the fire and no burning out had been done, hence a sinuous line of great length and loss of line in the northeast corner due to lack of burning out directly behind the plow unit.

Crew foremen need more training in burning out to the furrowed or trenched line. This fault was very pronounced on the south half of the fire. The foreman would not burn out and I had to do the job myself in order to get it done. Also, the foremen did not stay with their crews, directing their work, but left them with leaders and assistant leaders in charge. This fault possibly results from lack of knowledge of the ability of individual foremen and rating them too high on the fire roster.

I noticed a great deal of wasted human effort through the lack of training or knowledge in what constitutes a fire hazard. When large living aspen is cut down close to the fire line as a hazard, I believe more training is necessary to correct this error in judgment.

Extract from a Board of Review Report—Name of region, forest, and fire withheld.—This fire became large primarily because of ineffectual control work by green, slip-shod C. C. C. crews used in initial attack. Subsequent losses of line appeared to be due chiefly to reburns caused by failure to burn the moss from trees. The story is well covered in the Forest Board of Review write-up and accompanying conclusions for this fire.

The use of trail builders in building a truck trail into the fire allowed the largest construction job on a fire yet undertaken to be completed rapidly and when needed. Radio was also advantageously used.

The weaknesses that showed up are enumerated below as a checklist for action to avoid repetition in future:

1. Water supply for men on top of ridge was not made available until close to the end of the campaign.

2. There was lack of knowledge of the situation at various times on the part of directing heads. Also failure to calculate size of job and manpower needed.

3. Shortage of right tools at the right time and place.

4. Men were instructed to get tools from forces they were relieving, resulting in failure to contact and no tools for relief forces.

5. Moss on the trees was not burned off.

6. After fire was lost, men tried to fight too close for about 2 days.

7. Backfiring delayed; might easily have resulted in disaster.

8. Pessimistic outlook and manning for worst possible situation rather than existing.

9. Excessive manpower and overhead. Current manpower organization records were not maintained.

10. Weak line organization; high-caliber men in camp and not enough of this type on line.

11. Lack of prearrangements as to crews, trucks, and rations.

12. Insufficient and lack of proper handling of property; failure to check invoices of supplies resulted in considerable loss.

13. Wage rate and time-keeping difficulties, resulting in minor labor troubles. Standard crew-boss time records would have helped.

14. Records not adequate, not coordinated or properly checked, resulting in duplicate orders for men and equipment and supplies.

15. Off-shift men, especially overhead, did not go to bed when possible in many cases.

16. Lack of transportation from camp to line, etc.

17. Outside pack stock could have been ordered earlier.

18. Crews got lost. Adequate guide service needed.

19. Definite marking of station locations on the line and on a duplicator map would have prevented crews or bosses getting on wrong sectors.

20. Excessive costs on this fire. Records of charges to fire not kept currently so that reasonably accurate charges could be made. Arbitrary prorating of costs distorted picture of costs on this and the other fires.

(Aside from the foregoing the management of this fire was all right. But before you set this instance down as a horrible example of what could not happen in your territory, consider two questions: (1) Do you know, and have you faced what really happens on your own jobs, and (2) have your larger fires ever been subjected to the type of honest and searching forests and regional inquiry from which the foregoing resulted? Good management of larger fires is probably more exacting than any other management job except the direction of a battle in human warfare. Blunders, wastes, failures cannot be wholly eliminated. But they can be reduced. The analysis in this case has what it takes to do just that.—Ed.)

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technology may flow to and from every worker in the field of forest fire control.

